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ERRATA.

p. 13, line 6, for "dichotomous by" read dichotomously.
p. 21, line 15, for first "of" read by.
p. 21, line 14 from below, for "or" read and.
p. 22, line 5 from below, for first "is" read functions as.
p. 39, line 2 from below, for "Sandburg" read Sandberg.
p. 66, line 2 from below, for "371" read 372.
p. 92, line 19 for "patatoes" read potatoes.
p. 125, line 13, for "controspheres" read centrospheres.
p. 126, line 7, for "controsomes" read centrospheres.
p. 133, line 8, for "4–6-" read 1–6-.
p. 147, line 17, for "made useful" read put to some useful end.
p. 147, line 8 from below, for "second" read third.
p. 148, line 3, for "an" read a precarious.
p. 148, *dele* last sentence in paragraph 2.
p. 148, line 23, for "Cohobba" read Cohabba.
p. 149, line 19, for "Hogan" read Logan.
p. 150, line 5, for "Mancas" read Mancos.
p. 161, line 10, for "he" read the.
p. 206, line 6, for "*aurulenta*" read *amulentæ*.
p. 241, line 8, add " at end.
p. 278, line 18 from below, for "simply" read simple.
p. 281, below figure insert explanation: Diagram of longitudinal section of root tuber of *Isopyrum occidentale.*—*a*, endodermis; *b*, proto-xylem; *c*, pericycle; *d*, xylem; *e*, medulla; *f*, sclerenchyma.

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BOTANICAL GAZETTE

JANUARY, 1896.

Notes on Carex. XVIII.

L. H. BAILEY.

WITH PLATE I.

1. CAREX IN THE CHECK-LIST.—There are two or three features of the Carex catalogue in the "List of Pteridophyta and Spermatophyta" which do not represent my own views (although my name is attached to the article), and to which I wish briefly to advert. My chief reason for discussing the subject is to bring up one or two features of the nomenclature of the Check-List.

a. My first remark has reference to the double or algebraic citation of authorities. It is admittedly the purpose of all citation of authority to identify the name; giving honor or "credit" to the author of the name is no part of the object. If we adopt the double citation system, we enclose in our parenthesis the name of the author of the given specific or varietal name, and this is followed by the author of the accepted combination; or if only one name is cited, it is understood to stand for both the creation and the combination. Thus, *Carex granularis Haleana* (Olney) Porter, means that the name Haleana was first proposed by Olney and was placed in combination with Carex granularis by Porter. But now suppose that Olney himself, instead of Porter, had later attached the name to Carex granularis. The proper citation would, in that case, certainly be *Carex granularis Haleana* (Olney) Olney.

But this method the Check-List does not allow, although I do not know why. Attention was called to it at least twice when the List was going through the press.

Let us take a concrete example. Carex no. 772 in the list is *Carex cephaloidea* Dewey, Rep. Pl. Mass. 262. (1840).

This citation indicates that the word cephaloidea was first used for a Carex by Dewey in the Catalogue of Massachusetts Plants published in 1840, otherwise there should have been a double citation; but the name was really made four years before this time, and it is so stated in the synonymy: *Carex muricata* var. *cephaloidea* Dewey, Amer. Journ. Sci. **11:** 308. 1836.

Now if John Smith had first made cephaloidea, his name would have appeared in the parenthesis; then why not Dewey's? Certainly no personal element can enter into the matter, and if the double citation is worth anything, it is valuable only in proportion as it adheres to the principle of keeping tally of the two points in the history of the trivial name—its creation and its latest use. The citation, therefore, should be *Carex cephaloidea* (Dewey) Dewey.

The only reason which I have ever heard for the refusal to cite the same authority twice is that it gives the author too much "credit"; but certainly credit can be no part of nomenclature. I am not urging this repetition of the same author because I believe in the double citation of authorities, but because I should like to see the system consistent with itself.

It seems that "credit" is really too much concerned in the promulgation of this system of double or parenthetical citation of authorities. At all events, I am not convinced that the system has intrinsic merits in any superlative degree. I cannot conceive that a system of botanical nomenclature should have for its object a record of the history or migrations of names. Its sole purpose should be to designate particular plants unmistakably and concisely, and the authority is cited only for the purpose of distinguishing the name which John Smith makes from a like name which James Brown may chance to make. If, however, the authority is to constitute a history and lexicon of the name, it should comprise the complete history, and should have a parenthesis for every occasion in which the name has changed hands, or changed places. If the citation is to include an index of the synomymy, let us have the whole of it. I do not know why we should select out the first and last points and omit all the intermediate events. For instance, *Carex mirabilis* was described by Dewey; it was made a variety of *C. festucacea* by Carey; of *C. cristata* by Gray; of *C. lagopodioides* by Olney; and of *C. straminea* by Tuckerman. Then the citation of authorities should be: *Carex straminea mirabilis* (Dewey) (Carey) (Gray) (Olney) Tuckerm.

If one were to make any full discussion of this subject upon its merits, he would need to decide first of all what a name is. This question lies at the very bottom of the present unrest in nomenclature, yet it is one which is not freely discussed by itself. Most of the attention of controversialists is given to special and generally subsidiary points in nomenclature. Is the name of the plant—that form of expression by which it is to be distinguished from all other plants—one word or two, the original specific or varietal name or the combination of these with the generic name? Is nomenclature monomial or binomial? Is *bullata*, or *Carex bullata*, the name of a sedge? If bullata is the name, then I must give this name to no other plant for I shall then introduce confusion; that is, I shall make synonymous names. Linnæus is supposed to have taught that a name has two coordinate and essential parts, and that either part alone is not capable of designating any particular plant. How, then, do we introduce a different system and then take Linnæus as our starting point?

A name of any natural object must have two elements: it must unequivocally designate the object; and it must have some element of permanency in usage. Now, *bullata* does not designate my plant; it does not distinguish if the plant is Carex, Salix or Cabbage. But *Carex bullata* is designative, and it has more elements of permanency than bullata from the very fact that it is explicit, and also because the combination of the two words—Carex and bullata—is likely to be more recent, and therefore better understood, than the creation of either one alone. The proposed new nomenclature is boisterous for stability. Very well! But why is not a combination of two words just as "stable" as one word? It is easier to get at the proper combination than it is at the origin of the single word, because the combination, as I have said, is the more recent event. Why not tie up at the first safe landing place, rather than to run forever backward in a profitless search of some shipwrecked name?

b. My second advertence to the Check-List is in reference to the exaltation of the varietal name. It was not my privilege to attend the meeting of the Botanical Club at Madison, but it is recorded that a resolution was introduced "that the varietal name be subject to the same laws of permanency as those which govern the specific," and that after nine persons had discussed the proposition "the Club adjourned without reaching a vote." (BOT. GAZ. **18:** 343.) The other three propositions submitted by the committee on nomenclature at that time were adopted. It is clear that there was at least much doubt amongst the members as to the wisdom of treating the varietal name with the same exactness as we treat the specific name; yet, in the face of this lack of support for the proposition and virtual refusal of it, this same committee itself adopts a rule "that the original name is to be maintained whether published as species, subspecies or variety." I think it is only fair for me to say, therefore, that the manuscript for Carex in the Check-List was prepared with the customary or old-time treatment of varietal names, and that the following numbers do not represent my own desires, at least not until the whole question of nomenclature shall have been passed upon by some organization fairly representing the botanists of the world: 765, 785, 808, 867, 888, 901, 902, 955, 958.

c. My third remark upon the Check-List concerns the suppression of names printed without description or synonymy. Such names, and those occurring in exsiccatæ, are held not to have been "published." Wahlenberg published *Carex glareosa* in 1803. Dewey published *C. ursina* in 1835. In 1884, I wrote *Carex glareosa* var. *ursina* in my Carex Catalogue without synonymy or comment except to add "*Arc. Am.*" to designate range; and under *Carex ursina* Dewey, I said "see *glareosa.*" Of course, this is not publication, yet no one could mistake what I meant. I find in the Check-List:

Carex glareosa ursina (Dewey) Britton.

. . . .

Carex glareosa var. *ursina* Bailey, Carex Cat. (1884), name only.

Now, I do not object to the name ursina standing to the authority of "(Dewey) Britton," for my own cataloguing of it ought not to stand for a publication; but it seems to me to be a good principle to enunciate that *if a given name is so unmistakable that it can be cited as a synonym, it is also sufficiently unmistakable to be cited as a valid name.* That is, if *nomina nuda* are held not to have been published, then they can be cited neither as valid names nor as synonyms, for synonyms are only published names which have been laid aside for the time.

d. Another point of which I wish to speak is the reference of *Carex microglochin* to the genus Uncinia. The see-saw between Carex and Uncinia has upset this poor little plant from the days of Wahlenberg and Sprengel. The technical character of the racheola appearing in the perigynium seems to put it into Uncinia, but many of our common carices develop racheola occasionally. Uncinia is now accepted rather more upon habit than upon this one technical character, and nearly all the later treatment of the genus refers the plant in question to Carex.

✓2. **Carex Hassei,** n. sp.—Pacific coast representative of the type of *C. laxiflora:* differs in paler color and much narrower leaves; and especially in the perigynium, which is about as long as the scale, not trigonous nor beaked, the point only slightly bent, not striate or stipe-like at base, the walls thin and soft; scale broad, the point scarcely cusp-like; bracts rarely leaf-like.—In a meadow, San Antonio Cañon, San Bernardino range, California, 4,500ft altitude. H. E. Hasse, July, 1894.

✓3. **Carex multimoda,** n. sp.—(*C. festiva* var. *gracilis*, authors). *Carex festiva*, the Rocky Mountain and Pacific coast representative of *Carex straminea*, is one of the most perplexing carices in the American flora. A good part of the confusion arises, however, from the fact that the species is made to comprise many unlike forms. If two or three of these outlying forms were to be set off as specifically distinct, the species would be much easier to understand. The plants commonly referred to var. *gracilis*, which I now erect into a species, are very slender, with narrow leaves (lacking wholly the stiff aspect of *C. festiva*), the spikes small and mostly massed into a little tawny or dark head; points of the narrow perigynia generally conspicuously spreading.—Seems to be distributed from the Sierras of California to British Columbia. More closely allied to *C. subfusca* W. Boott, than to *C. festiva*. *C. subfusca* is more *straminea*-like, with more distinct roundish spikes, and a stiffer habit.

✓4. **Carex Idahoa,** n. sp.—A dioecious member of the Microrhynchæ, but with three stigmas, and not closely related to any carex which I know; possibly *C. salina* is its nearest kin. Tall and slender (about 2ft high), the culm exceeding the flat rather short leaves; spikes generally three on both staminate and pistillate culms (sometimes one on staminate culm), all close together but the terminal one twice longer than the others (about an inch long, and cylindrical), the lowest one generally on a stalk a fourth inch long, all of them ferrugineous in color; bracts very short, only the lowermost prominent and that one little exceeding the pedicel of the spike; perigynium very small, trigonous and not inflated, smooth and nearly or wholly nerveless, contracted both ways, abruptly terminated in a short and entire beak; scale twice longer than the perigynium, lance-pointed, the margin dull brown and the mid-nerve broad and lighter colored.—Beaver Cañon, Idaho, Aug. 7, 1895. P. A. Rydberg (no. 2,339).

5. **Carex Congdoni,** n. sp.—Closest ally of *C. Yosemitana* Bailey (*C. Sartwelliana* Olney), from which it differs in the nearly or quite complete absence of pubescence on the leaves and sheaths, an androgynous terminal spike (pistillate at top), and especially in the shape of the perigynium, which is lanceolate and very gradually attenuated into the beak-like top, and slightly toothed. The perigynium of *C. Yosemitana* is ovoid, prominently widened above the middle and very abruptly contracted or rounded into a short and entire beak; that of *C. Congdoni* is narrowly lanceolate or spindle-shape. I suspect that the terminal spike of C. Congdoni may be found to be sometimes wholly staminate. The Atlantic ally of these plants is *C. vestita* Willd.—California: Mt. Warren Pass, Tuolumne county, and east side of Mt. Warren, Mono county. J. W. Congdon, 1894.

6. **Carex Arkansana,** n. sp.—(*C. rosea* Schk., var.? *Arkansana* Bailey, Bot. Gaz. **13:** 87.) Sufficient material has now accumulated to show the true character of this plant, and it is clearly unlike *C. rosea.* It differs in its larger and glomerate spikes, the very broad and prominently spongy-based perigynium, and particularly by the two or three leafy bracts (from 1 to 5^{in} long) which subtend the lower spikes. It differs also from *Carex Muhlenbergii* var. *australis* by its slender habit and long narrow leaves, by the long and leafy bracts, and especially by the spongy and broad-based perigynium. I have the plant from La Fourche creek, near Little Rock, Arkansas (H. E. Hasse; the original locality), and from three places in Indian Territory: Muskogee, M. A. Carleton, 1891, (no. 79); Sapulpa, B. F. Bush, 1895, (nos. 979, 981 and 1,038); Catale, B. F. Bush, 1895, (no. 995).

7. **Carex Eggertii,** n. sp.—An ally of *Carex bullata* Schw., but more *lupulina*-like: coarser, with broad flat leaves; spikes two to four and approximate, whitish, longer than in

C. bullata, much more erect, looser; perigynium prominently ascending, long-pointed, coarsely several-nerved, little or not at all glossy nor red-brown at maturity, the beak rough and deeply toothed; achenium of characteristic shape, being very sharply triquetrous but short, each of the three angles being produced into a callous point at the middle, so as to make the achenium nearly equally six-sided. The perigynium is much larger than that of *C. bullata*, more inflated and gradually tapering into the long beak.—In a swamp, "growing as single individuals from runners," Butler county, Missouri. Henry Eggert. My first impression of this carex was that it might be a hybrid, but studies of various specimens from collections by Mr. Eggert have led me to regard it as a good species. Mr. Eggert is also of the opinion that it is not a hybrid. It is uniformly fruitful, which carex hybrids are not likely to be.

8. CAREX ALBICANS Willd. in herb.; Spreng. Syst. Veg. **3:** 818. 1826. *C. Emmonsii* Dewey, var. *elliptica* Boott Illustr. 97, *pl. 287.* 1860. *C. Peckii* Howe, Rept. State Bot. N. Y. 1894, 40 (in 47th Rep. N. Y. Mus. Nat. Hist.). This is certainly a well-marked species, and, as Dr. Howe remarks, it is allied rather more to *C. deflexa* than to *C. varia*. It ranges from New England and Pennsylvania to Minnesota and northwards, and it probably occurs south of this limit. It is distinguished from *C. varia* by its lighter color, fewer and much shorter and broader leaves, which are greatly overtopped by the stiff straight culms, and by the closely glomeratespikelets and mostly very inconspicuous staminate spike, and the rather longer perigynium. *C. varia* has slender and generally curved or weak culms which are commonly overtopped by the dark narrow and long-pointed profuse leaves, mostly separated spikes and prominently protruding staminate spike. Willdenow's name, *C. albicans*, is an appropriate one, denoting the light color of the plant, although it appears to have been chosen because of the light-colored spikes. Willdenow's specimen is said to have come from North Carolina. *Plate I* admirably distinguishes the species.

9. CAREX GRANDIS Bailey, var. **Helleri,** n. var.—Differs from the species in the smallness of its stature and spikes (10–15$^{\text{in}}$ high), and narrow lax leaves; spikes two to three, $\frac{1}{2}$ to $\frac{3}{4}^{\text{in}}$ long, contiguous near the top of the culm.—Franklin county, southeastern Virginia, "in the shade in a well wooded

and very soft swamp, in company with Saururus cernuus, Dianthera ovata, and Proserpinaca palustris." A. A. Heller (no. 989), June, 1893.

10. CAREX QUADRIFIDA Bailey, var. **caeca,** n. var.—Smaller than the species (10–16^{in} tall); heads uniform dull dark brown; spikes four or five, the lowest one sometimes an inch remote, a half inch or less long, mostly small and slender; perigynium smaller than in the species; scales equaling or exceeding the perigynium, broad, not sharp-pointed; culms rather slender, considerably exceeding the broadish, long-pointed leaves.—Tanquitz Meadow, San Jacinto mountains, San Diego county, California, 8,000^{ft} altitude. H. E. Hasse, July 1892. Perhaps a good species.

11. CAREX NEBRASKENSIS Dewey, var. **ultriformis,** n. var.—More like the var. *prævia* Bailey (*C. Jamesii* Torr.) than the type of *C. Nebraskensis*, but differs in the habitually much narrower leaves ($\frac{3}{16}^{in}$ or less wide), and particularly in the short, often almost globular spikes (which are $\frac{1}{2}^{in}$ or less long).—Ritzville, Adams County, Washington, 1,700^{ft} altitude. J. H. Sandberg and J. B. Leiberg (no. 194), 1893.

12. CAREX FETA Bailey, var. **multa**, n. var.—*Carex feta* generally has a long and loose head of well separated and more or less rounded or cylindrical-conical spikes, but the proposed variety *multa* has less defined and looser or more chaff-like spikes in a glomerate and often compound head. This variety is to *C. feta* what var. *cumulata* is to the eastern *C. albolutescens*. I have it from San Jacinto Mountains, San Diego County, California, and from two stations in Oregon.

13. **Carex prasina** × **crinita,** n. hyb.—A well marked hybrid of these two species has been found at Summit, N. Jersey, by J. R. Churchill, and in Summers County, West Virginia, by C. F. Millspaugh. Judge Churchill's specimens have more the aspect of *C. prasina*, whilst Dr. Millspaugh's seem rather more to resemble *C. crinita*, especially in the foliage. Both collections lack the robustness of *C. crinita*.

14. **Carex scabrata** × **crinita** Fernald in herb., was collected in 1891, on Mt. Clinton, N. H., by Dr. Geo. G. Kennedy. It seems to be a very good intermediate between the two species, although apparently losing something in size and vigor.

Cornell University, Ithaca, N. Y.

A new Californian liverwort.

DOUGLAS HOUGHTON CAMPBELL.

WITH PLATE II.

In March of last year the writer received from San Diego a liverwort, which on examination seemed to differ very much from any described form, and was therefore subjected to a somewhat careful study. An investigation of the structure of the plant showed such marked peculiarities that it could not be satisfactorily referred to any described genus, and therefore it seemed necessary that a new genus should be established to contain it. For this the name Geothallus is proposed.

The plants were growing in company with *Ophioglossum nudicaule*, and were collected by Mrs. Brandegee, to whom I am also indebted for additional specimens which made it possible to determine the most important points of structure, and the systematic position of the plant.

When the specimens of Ophioglossum were received, they were not examined immediately, but the clods of earth upon which they were growing were watered, and placed under bell-jars, where they were left undisturbed for a week or more. When they were examined, at the end of this time, my attention was at once drawn to a number of bright green, palmately lobed little plants which had not been noticed when the specimens were first received. They were evidently thallose liverworts of some kind whose growth had been stimulated by the moisture under the bell-jar. A careful examination of Schiffner's Hepaticæ[1] failed to throw any light upon the systematic position of the plant, and specimens were then sent to Dr. L. M. Underwood, who reported that it was a form quite new to him. There were no sporogonia found in the first lot of specimens, but later these were obtained when it was evident that the plant belonged to the group of anacrogynous Jungermanniaceæ to which Goebel[2] gives the name Anelatereæ, owing to the absence of perfect elaters. As at present but a single genus belonging to this group, *Sphæro-*

[1] Engler and Prantl, Die natürlichen Pflanzenfamilien 90, 91.

[2] Goebel, Die Muscineen. Schenk's Handbuch der Botanik **2**: 363.

carpus, is known from the United States, and this genus is in some respects the most primitive of all known Hepaticæ, the discovery of an allied genus is of more than ordinary interest as perhaps throwing some light on the affinities of the lower Hepaticæ.

The thallus, as first observed, consisted of a cylindrical basal portion, expanding forward into a number of spreading irregular lobes, so that the whole was somewhat fan-shaped (Fig. 4). Further examination showed that this fan-shaped thallus was really a secondary growth from the primary thallus which was more or less buried in the earth (whence the name "Geothallus"). At the time they were received, the plants had apparently about completed the season's growth and were beginning to dry up; and as they had lost much of their original green color and were partially buried in the ground, were quite overlooked.

The older thallus is more or less wedge-shaped, but often nearly orbicular in outline, about 5–7^{mm} in length by 3–4^{mm} in breadth (figs. 1–3). It is usually simple, but occasionally once dichotomous (fig. 3). The body of the thallus is thick and fleshy, passing quite abruptly into the margin, or wings, which consist of more or less regularly lobed laminæ composed for the most part of a single layer of cells. These marginal laminæ are sometimes arranged quite regularly, so that they recall the similar leaf-like laminæ of Fossombronia; indeed in some cases the general aspect of the plant is not unlike the common Californian *Fossombronia longiseta*. In addition to these marginal lobes, there are numerous dorsal laminar outgrowths, which may almost completely conceal the dorsal surface of the thallus (fig. 2, *a.*), and give it a very characteristic appearance. The plant is attached to the ground by numerous colorless rhizoids, and from the ventral surface, especially near the apex, are jointed, glandular hairs, which curve over the growing-point, and are like those characteristic of most of the thallose Jungermanniaceæ.

If the old plants are given plenty of moisture, growth is resumed, and the apex of the thallus rapidly grows out into the fresh green shoot first observed. The marginal lobes of these secondary growths are narrower and longer than in normally developed specimens, due, no doubt, to the excess of moisture where they were grown.

The specimens were too old for a satisfactory study of the sexual organs, and these were not produced in a normal manner upon the secondary shoots. Enough was seen, however, to show that in a general way both archegonia and antheridia are similar to those of Sphaerocarpus. The archegonium (fig. 7), however, is larger, and the neck somewhat longer and straighter, and it is not so distinctly stalked. The antheridium is much the same shape as that of Sphaerocarpus, but the early divisions are apparently less regular. A very marked difference between the genera is the much greater number of the sexual organs in Sphaerocarpus, where they completely cover the the dorsal surface of the thallus. In Geothallus they are produced much more sparingly, and there is, apparently, no difference in the form and size of the male and female plants, whereas this is very noticeable in Sphaerocarpus. Indeed it is not impossible that Geothallus may sometimes be monoecious. As in Sphaerocarpus the sexual organs are surrounded individually by a sac-shaped envelope, which is relatively much less developed than there.

The sporogonium resembles closely that of *Sphaerocarpus terrestris*, but is larger. The fully grown sporogonium is a nearly spherical capsule about 1^{mm} in diameter, connected by a very short seta to the bulbous foot which is sunk in the thallus. Owing to the nearly sessile position of the archegonium, the foot is not raised above the level of the thallus as is the case in Sphaerocarpus. The sporogonium wall is composed of a single layer of rather thick walled cells, which at maturity are almost black in color. The capsule is filled with a mass of spores intermingled with thin-walled oval cells like those found in Sphaerocarpus (fig. 8, *c.*). These sterile cells which here are probably only nutritive in function, are doubtless the homologues of the elaters of the more specialized Hepaticæ. They are oval cells, measuring from 48—108μ in length, and as a rule are relatively longer than the similar cells of Sphaerocarpus. They contain some chlorophyll, and scattered granules, apparently of albuminous nature, but little or no starch, while in Sphaerocarpus there are numerous large starch granules present.

The spores are very large, and at maturity separate completely. They are nearly globular and range from 120—140μ in diameter. The wall is very thick, and in section (fig. 6, *b.*) shows two well marked layers, perinium (epispore), and exospore. An endospore is also probably present, but in microtome sections is not clearly differentiated from the inner layers of the exospore. The perinium appears perfectly homogeneous, and is smooth except upon the ventral surface of the spore where it is folded so as to produce reticulated ridges which in section have the appearance of spines (fig. 8, *b*, *c*.). The character of the spore-contents was not especially studied beyond noting the fact that the nucleus is quite small, as is usually the case in the spores of liverworts.

The most peculiar feature of the plant, and one which appears to be unique among Hepaticæ, is the formation of tubers by means of which it becomes perennial. These tubers were always met with in the older individuals, and in the secondary shoots from the older thallus were also developed after a short time. The tuber consists of an oval mass of cells derived from the interior tissue of the thallus, and including its growing-point. These cells are densely filled with coarsely granular contents, mostly made up of albuminous granules and oil-drops, very little starch being present. The first indication of the formation of the tuber is an accumulation of granular matter in the interior cells of the thallus just back of the apex, and this extends in all directions until it includes nearly the whole central region of the thallus, as well as the cells of the growing point. The chlorophyll disappears from the cells and sections of the ripe tuber appear white and opaque. Surrounding the central tissue is a more or less clearly defined dark cortex, which does not, however, extend over the cells of the growing point. The whole tuber is surrounded by a loose brownish envelope composed of the dead outer cells of the thallus. The full grown tuber is a flattened body from 1–2^{mm} in length and about half as wide.

The tubers are obviously a special provision for carrying the plant through the long dry season. Specimens kept perfectly dry from May until about the first of October, germinated promptly when placed in water for a few days. Growth begins by the cells near the growing point turning green and the latter resuming its activity. The development of the young plants from the tubers has not yet been studied in detail, but it is hoped soon that it may be possible to follow out completely the life-history of this interesting form.

There seems no doubt that the affinities of Geothallus are with the lower Jungermanniaceæ, the Anelatereæ. As already stated it agrees with Sphaerocarpus in the general characters of the sexual organs and sporogonium, but the very different structure of the thallus, the similarity of the male and female plants, and especially the formation of the tubers, make it impossible to unite it with that genus.

GEOTHALLUS, nov. gen. — Plant thalloid, simple or dichotomous by branched, thallus fleshy, wedge-shaped or nearly orbicular, partially buried in the earth; margin of thallus divided into irregular leaf-like lobes, similar laminæ upon the dorsal surface; ventral surface with numerous simple, colorless rhizoids and jointed glandular hairs near the apex; sexual organs scattered over the dorsal surface, each surrounded by a sac-shaped envelope: sporogonium globular, with very short seta and bulbous foot; capsule-wall composed of a single layer of black cells; spores very large, mingled with thin-walled sterile cells; plant perennial by means of tubers developed at the end of the growing season.

G. tuberosus, nov. sp.—Plant dioecious, male and female alike: spores black, smooth except upon the ventral surface where there are reticulate ridges, 120—140μ in diameter; sterile cells 48—108μ in length.

Sandy soil near San Diego, California, growing with *Ophioglossum nudicaule*. Collected by Mrs. Katherine Brandegee, March, April, 1895.

Stanford University.

Explanation of Plate II.

Geothallus tuberosus Campbell.

Figs. 1, 2. Two old plants; *a*, seen from above; *b*, from the side; × 4.

Fig. 3. A large specimen showing dichotomy; × 4.

Fig. 4. Secondary shoot from a specimen which had been grown under a bell-jar; × 10.

Fig. 5. Median section of a fruiting thallus, showing *sp*, a sporogonium, *t*, the young tuber; × 10.

Fig. 6. *a*, microtome section of a ripe sporogonium, × 30. *b*, microtome section of a ripe spore, × 150. *c*, transverse section of the reticulated ridges upon the ventral surface of the spore, × 300.

Fig. 7. An old archegonium, seen in optical section, × 100.

Fig. 8. *a*, tetrad of nearly full-grown spores, × 150. *b*, two ripe spores, × 150. *c*, three sterile cells, × 150.

Further criticism of Mr. Nash's "New or noteworthy American grasses."[1]

Notes on Sporobolus.

Some confusion exists in regard to certain North American species of Sporobolus, as is manifested in botanical publications of this country, and especially in our larger herbaria. A writer in a recent *Bulletin* of the Torrey Botanical Club attempted to clear up this confusion, but, through an evident misconception of the species, has unintentionally added to it. *Agrostis brevifolia* Nutt. has been taken up for *Sporobolus cuspidatus* (*Vilfa cuspidata* Torr.), and there is no doubt as to their identity. Nuttall very clearly and fully described his species (*Agrostis brevifolia*) in the first volume of his "Genera," and *Sporobolus cuspidatus* is equally well characterized by Hooker in the second volume of his "Flora Boreali-Americanæ," and there is only one grass in the region of the type localities to which these descriptions could apply. I can not help thinking that the writer in the *Bulletin*, above referred to, must have failed to fully read Nuttall's description of *Agrostis brevifolia*, or he would not have applied it to the very distinct species noted below. One essential and almost decisive character given by Nuttall for *Agrostis brevifolia* is: "Culms solid and compressed . . . not terete, but solid and ancipital." This character affords a clue to Nuttall's plant, and, combined with the others given, leaves no doubt as to its identity with *Sporobolus cuspidatus*, for there is no other grass within the range (Fort Mandan on the Missouri) possessing all these characters. Another good character presented by this grass is a minute pubescence at, and extending for a greater or less distance below, the nodes. This character holds good throughout all specimens in the National Herbarium.

For the species we have the following synonymy:

Sporobolus cuspidatus Scribn. Bull. Torr. Bot. Club **10**: 63.
Sporobolus brevifolius (Nutt.) Scribn. Mem. Torr. Bot. Club **5**: 39.
Vilfa cuspidata Torr. Hook. Flor. Bor. Am. **2**: 238.
Vilfa gracilis Trin. Agros. **1**: 82. not *V. gracilis* Trin. l. c. 52.
Agrostis brevifolia Nutt. Gen. **1**: 44. 1818.

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[1] The two following articles received independently may be combined by the editors under this caption. See also Bot. Gaz. **20**: 554. D 1895, and Mr. Nash's reply on p. 41 of this number.—Eds.

Represented in the National Herbarium by specimens from: Montana (350 Scribner); Nebraska (771 C. L. Shear, 2,551 Rydberg, and 2,795 Fred Clements); Devil's Lake, N. Dak. (C. A. Geyer); Minnesota (E. P. Sheldon); Missouri (no. 423*b* B. F. Bush), Kansas (Dr. Carruth, and Mr. Swingle); Colorado (S. M. Tracy).

The grass which appears to have caused the existing confusion here, is the more slender and heretofore unidentified *Vilfa Richardsonis* Trin., of which the following is the synonymy:

Sporobolus aspericaulis (Nees).
Muhlenbergia aspericaulis Nees, ex Trin.
Vilfa Richardsonis Trin. Agrost. 1: 81.
Vilfa cuspidata auct. plur., not Torrey in Hook. Flor. Bor. Am.
Sporobolus brevifolius Nash, not Scribner.

This species has a very wide range, and is well represented in the National Herbarium: Northern Maine (C. G. Pringle); (147 Fernald); New Brunswick (19 John Brittain); Anticosti (48 John Macoun); Oregon (765 Cusick); Colorado (1075 John Wolfe); Idaho (552 Coulter); Nevada (1279 Sereno Watson); Montana (410 and 627 C. L. Shear), etc.

This is a very slender, erect grass, branching only at or near the base, with sheaths much shorter than the internodes, and very short, almost filiform, arcuate-spreading leaves. A constant character, mentioned by Trinius, is that the culms are minutely, but distinctly punctate, "*punctis asperis obsiti.*" This species is very closely allied to *Sporobolus depauperatus* (*Vilfa squarrosa* Trin.), into which it may pass.

Referring again to the article published in the Torrey Bulletin, I would say that, if *Sporobolus vaginaeflorus* Vasey be regarded as a species distinct from *Sporobolus vaginaeflorus* Wood, why make a new name for the former, when there is one that might be taken up? *Cryptostachys vaginata* Steud. is evidently *Sporobolus vaginaeflorus* Vasey, and, carrying out the premises, the rules of nomenclature require us to take up Steudel's name which gives us for the species the following synonymy:

Sporobolus vaginatus (Steud.).
Sporobolus vaginaeflorus Vasey, not Wood.
Sporobolus neglectus Nash (1895).
Cryptostachys vaginata Steud. (1855).

It is quite possible that there are other and yet older names, but at all events *Sporobolus neglectus* is an unnecessary addition to a much-burdened synonymy.—F. LAMSON-SCRIBNER, *Washington, D. C.*

The validity of Mr. Nash's changes.

In a recent article on the subject of "New or Noteworthy American Grasses,"[1] several new species are described and a number of new names applied to old ones. *Erianthus compactus* is a form which has been known to botanists for seventy years, being widely distributed through the eastern manual range. It has been included in the manuals under *E. saccharoides* Michx., and *E. alopecuroides* Ell., and has been commonly known by these names, yet the author neglects to mention the fact and hence leads us to infer that it is an entirely new discovery. The change in the name is said to have been made because there is in the Herbarium of Columbia college a fragment of Gronovius' number 133,[2] which has the twisted awn, "aristis tortuosis" of the original description of *Andropogon alopecuroides* Linn. Munro,[3] who has examined the grasses of the Linnaean Herbarium, says: "The numbers in the Herbarium refer to those used in the first edition of the 'Species Plantarum,' Linnaeus' own copy being very carefully marked by himself. In the following list I have used these numbers, *underlining* them, as was done by Linnaeus himself, thus 1, 2, etc., to imply that the plant was actually in the Herbarium. I have carefully examined every grass in the Herbarium; and in annexing the following list of names which I consider they should bear, I trust the list may be of some little use to botanists who are unable to consult the Herbarium itself."

Munro gives l. c. 52, in his subjoined list, under *Andropogon:* "4. *A. alopecuroides*, from North America, is *Erianthus saccharoides* Mich." Hackel[4] places the Linnaean species, excluding Sloane's synonym, under *E. saccharoides* Michx., subspecies a, *genuinus*. He does not consider the twisting of the awn a character of specific value. The description of Mr. Nash's new species does not differentiate his plant from

[1]Bull. Torr. Bot. Club. **22:** 419. 1895.
[2]Linn. Sp. Pl. 1045. 1753.
[3]Proc. Linn. Soc. Bot. **6:** 33 *et seq.* 1861.
[4]DC. Monogr. Phan. **6:** 128. 1889.

that so long known to American botanists as *Erianthus saccharoides* Michx., which according to Munro is the same as the specimen in Linnaeus' Herbarium. Are Munro and Hackel to be classed as blind guides leading the blind?

The genus *Panicum* is an exceedingly complex one, its species having a world-wide distribution. It has been divided by such distinguished botanists as Trinius, Nees, Bentham and Hackel into thirteen or fourteen sections, which appear somewhat artificial when viewing the genus in its broadest or world-wide sense. Local botanists and collectors have time and again raised these sections to the rank of genera. If we consider only the American species of Panicum, that group characterized as *Digitaria* by Scopoli, or *Syntherisma* by Walter, might perhaps be separated as a genus. But in our study of this genus we can not ignore the many foreign species which stand in intermediate positions and link the various groups together. The study of systematic botany is a study of relationships. The chief end of this branch of botany is not to provide every plant which possesses individual variations with a name. It is of the greatest importance that we know to what known species a new one bears the closest relationship. The synonymy given under *Syntherisma* is faulty, if we are to judge it by that of Doell,[5] who has furnished us the most recent monograph of this group of Panicums.

Concerning the species botanists have known for many years as *Panicum latifolium* L., but which we are informed must now be called *P. Porterianum* Nash, Munro[4] says: "17. *P. latifolium* L.! From Kalm, North America. A specimen attached to this from Carolina is *P. divaricatum* L., to which Sloane's figure, t. 71. f. 3, belongs; another, marked *latifolium* is *P. oryzoides* Sw." Concerning *P. divaricatum* he says: "From Jamaica. This plant has often been confounded with *P. latifolium*, and bears the names of *P. ruscifolium*, *maculatum*, *glutinosum*, and *agglutinans*. Another specimen of *divaricatum* is marked *arborescens* by Smith." According to this the Linnaean name does really belong to the North American species and not to "a tropical species," as stated in the article in question.

Panicum minus (Muhl.) Nash does not seem to deserve to be raised to more than varietal rank. It has a more slender habit than the common form of the species, but the other

[5]Doell in Mart. Pl. Bras. 2[2]: 128. 1871–6.

characters given by the author do not separate it from *P. capillare* L. As to the synonymy given, there must be considerable doubt until the type specimens of Pursh, Torrey and Bernhardi have been examined and compared with the form which we believe to be the variety *minus* Muhlenberg.

There is the same doubt concerning the validity of "Panicum boreale n. sp." In the manuals it is included under *P. dichotomum* L., being more closely related to that than to *P. laxiflorum* Lam. It certainly does not deserve specific rank, as it is only one of many forms that go to make up the species *dichotomum*. It is well named and perhaps deserves to be separated out as a form or variety. That can only be determined after a study of all the material obtainable. Here we may well quote a remark of Munro's:[3] "Amongst grasses I find the errors extraordinarily numerous. Many of these might have been avoided by consulting herbaria easily accessible; and very many might have been avoided by a little care, and less anxiety for the creation of species."

The genus *Ixophorus* Schlecht.,[6] "welche man Gattung oder Panicum-Section nach Belieben nennen mag," was, as the author states, based upon *Urochloa uniseta* Presl.[7] Some of the characters of the latter are: "Panicula composita e spicis plurimis alternis, flexuosis, patentibus.—Flosculus hermaphroditus palea superiori quarta parte brevior, lanceolato-linearis, stramineus paleæ cartilaginæ; inferior ovata, trinervia, *nervo medio in aristam brevissimam persistentem, excurrente*, inter nervum medium et lateralem utrinque sulco longitudinale natata." Is this plant a Setaria? Mr. Nash saw the true *Ixophorus* at the National Herbarium, but failed to recognize it. He has increased and obscured the synonymy of Setaria by an addition of four names.

I wish to enter a protest against the use of the word "scale" in describing the bracts of a grass inflorescence. The terminology most generally adopted by systematic botanists is that proposed by Bentham.[8] It has been adopted because of the great confusion caused by the various authors using different terms to denote the same organs. Morphologically these glumes are not scales. Each spikelet is a reduced branch. The empty glumes and the flowering glume are leaf sheaths. The palea is a prophyllum. The flower is lateral and

[6]Linnaea **31**: 420. 1861-62.
[7]Rel. Haenk. **1**: 319. 1830.
[8]Journ. Linn. Soc. Bot. **15**: 502. 1877.

never terminal except in certain Agrostis species and other grasses from which the palea is wholly absent, and there is no homology between the floral glumes and the true scales of a rhizome. The glumes are not borne upon the axis of the flower. The latter is a branch bearing a naked flower. If true scales exist in the grass spikelet they are represented by the lodicules to which the term *scale* has frequently been applied in systematic works.

The terminology of the organs of plants has occupied the attention of our ablest botanists, and there has been a manifest effort on the part of our best thinkers to make the terms employed definite, and so far as possible expressive of homologous relationship. Glumes, both empty and flowering glumes are expressive and accord with the principle just noted. They are everywhere employed in the botanical literature of the day and have become practically fixed in our language. That a botanical journal of eminent standing should inaugurate so radical a change in terminology without presenting any reasons for so doing is remarkable.—JARED G. SMITH, *U. S. Dep't of Agriculture.*

Some comments on those chapters in Kerner and Oliver's "Natural History of Plants," which deal with reproduction.

CONWAY MAC MILLAN.

The bringing out of an American edition of Kerner and Oliver's *Natural History of Plants*, together with its great attractiveness and generally great value, makes it certain that this work will be used throughout the United States as a reference book or encyclopedia of botany. It therefore seems sufficiently worth while to give some attention to the ideas that are promulgated in its pages. It is not a particularly pleasant task to point out imperfections in so beautifully printed and skilfully compiled a work as the one in hand, but if botanical students are to be referred to this *Natural History of Plants* by their teachers, and it is to be held before them as an authority, it is of the greatest importance that some of its shortcomings should be known that they may be guarded against by teacher and by pupil.

I shall confine myself in this paper to indicating some of the errors, as I take them, in only one division of the work—that is, the chapters on the *Genesis of plant offspring*, in volume II, pt. 1 (half-vol. III of the four vol. edition, Henry Holt & Co.). It is not too much to say that this part of the Natural History is absolutely untrustworthy, not only in its statements of theory but again and again in its statements of fact. I have convinced myself by reference to the original German edition that these errors are not those of the translators. In order to point out a few of them a series of quotations and comments will be given.

p. 6. "In most—probably in all—divisions of the vegetable kingdom, two kinds of propagation occur. In each case a single protoplast forms the starting point for the new individual but in the one, this protoplast does not require the special stimulus afforded by union with another."

p. 46. "If a fruit is to arise, the ooplasm, i. e. the protoplasm destined to initiate a new generation, must unite with the fertilizing protoplasm which is called spermatoplasm," and p. 46, "the union of two protoplasts constitutes the essence of fertilization."

Comment. The last quotation is truth but at variance with the others and, as will be shown, deeply opposed to later statements. It is not true that the "single protoplast" which forms the starting point for a new individual, sexually produced, requires any such stimulus. *This* "single protoplast" is the syngamete or resultant cell from gametic fusion. It is also erroneous to suggest that from the ooplasm arises the new individual. This, on the contrary, arises from the syngamete.

p. 9. "As the spores of ferns are not the direct result of a process of fertilization they are not parts of fruits but brood-bodies."

p. 15. "The only structure rightly to be considered a moss-fruit is that in which the embryo is produced as a result of fertilization."

p. 16. (Describing rupture of moss-calyptra.) "The coat of the *fruit* being torn away."

p. 47. "The ooplasm rendered capable of fertilization, of this particular kind of growth" (i. e., into a new generation) "is to be considered as an embryo, even in cases where no visible change has taken place."

p. 66. In mosses "it is best to look upon the formation of fruit as being complete as soon as fertilization has taken place."

Comment. Clearly the word *embryo* is used here as a synonym of fecundated-egg, oosperm, or syngamete. The structure called a moss-fruit is, as clearly, a fecundated egg together with the enclosing archegone. And the further development of a moss sporophyte is called a development from the *fruit.* Here terms are used in an unusual sense, but not even consistently as the context will show.

p. 47. "We consider every structure to be a fruit which is the product of fertilization and at the same time constitutes the first step towards the renewal of the fertilized plant."

Comment. From the above it is clear that the only structures properly termed *fruits* in flowering plants would be the micropylar syngamete nucleus of the embryo-sac (after fertilization has taken place), or the antipodal syngamete nucleus (under the theory of Morot, that this cell represents gametic components). Now as a matter of fact, it is not these structures that are termed fruits at all, by Kerner, but those entirely different bodies—the fruits in the popular sense. See p. 48.

"At one end of the chain we have the unicellular fruits of the microscopic desmids, at the other the fruit of the cocoa-nut, which is differentiated into seeds on the one hand, and, several envelopes on the other and is as large as a man's head."

p. 49. Cryptogams possess "organs of fructification not clearly visible without aid from the microscope, whilst the term Phanerogam will comprise such plants as have organs of fructification which are visible without aid from the microscope."

Comment. Remembering the definition given of *fruit* and of *fertilization*, it is at once apparent that the word fructification is used ambiguously above. Under Kerner's own definition the *fruit*, that is the body or embryo, arising from the fusion of two protoplasts, is quite as invisible to ordinary eyes in phanerogams as in cryptogams. Nor are the "organs" any plainer in the one case than in the other.

p. 49. "In cryptogams fertilization takes place in water or in a watery medium, whereas the process in phanerogams is accomplished almost exclusively in the air."

Comment. This is the old confusion between pollination, which is the scattering of spores on a favorable locality, and fertilization which, as is properly stated by Kerner, consists in the union of two protoplasts. As a matter of fact fertilization in phanerogams, under Kerner's own definition never takes place "in the air," but always in the tissues of the ovule and ovary. It would be quite as proper to say that the fertilization of all vascular cryptogams takes place "in the air," since in these spores are blown out of the sporangia into the atmosphere, thence to light on some favorable germination spot.

p. 47. "The cell wherein the spermatoplasm is brought to the proper form and composition for the purpose of fertilization is called an *antheridium* in the case of a cryptogam, and a pollen-grain in the case of a phanerogam."

p. 85. "Pollen consists of cells which contain spermatoplasm, and may be compared to the antheridia of cryptogams."

Comment. A more thoroughly vicious statement does not exist in plant morphology than this. Almost every statement and inference in it is erroneous. For the term antheridium, at least among archegoniates, is employed to designate, not a cell but an organ, and is properly employed by Kerner farther on (p. 65), where he describes in the ordinary manner how moss antheridia are produced, "mingled with paraphyses." The "cell in which the spermatoplasm is prepared," etc., is a *sperm-mother-cell* or spermatocyte, not an antheridium. Nor is a spermatocyte or antheridium in any degree homologous or analogous with a pollen-grain. For this, as every one knows, is a spore and produces a plant one cell-nucleus of which is a sperm, nor is there any definite antheridium or spermocytes in metaspermic flowering plants.

p. 68. Discussing the Filices: "The fertilized ooplasm now subdivides . . . and thus is produced a multicellular embryo which remains imbedded in the unaltered amphigonium (archegone). This structure, though scarcely differing at all from the fruit rudiment must be considered as a fruit. After a short period of rest the embryo germinates and the new generation which gradually makes its appearance as stem, roots and fronds emerging from the embryo continues to receive its food-stuffs through the mediation of the prothallium."

Comment. Here is an amazing account of the regular development, from the syngamete, of the ordinary sporophytic fern. The conception of the spherical embryo "germinating" is peculiarly gratuitous, nor is there the dormant period referred to. One might as well speak of the babe "germinating" after a dormant period and becoming a man.

p. 69. The account of the Rhizocarpeæ and Selaginellaceæ is badly confused. For example, speaking of the germination of microspores it is said that in Salvinia, Marsilia and Selaginella one or two cells are "pushed out through rents made here and there," whereas as a matter of fact this does not occur in any of the genera mentioned except *Salvinia*, nor is the phrase "rents here and there" at all definite enough.

p. 69. "The tissue produced from a macrospore in the Rhizocarpeæ and Selaginelleæ has been compared to the ovule as it occurs in the phanerogams."

And after a few comments on this surprising alleged homology, Kerner adds:

"But if it is made the basis of far-reaching speculations concerning the evolution of one group of plants from another, the descent of phanerogams from cryptogams, for example, I must enter an emphatic protest against any such proceeding."

Comment. The emphatic protest might have some weight if any such homology had ever been suggested. As a matter of fact the tissue produced from a macrospore has no possible homology with an ovule and no informed botanist since the days of Hofmeister ever supposed that it had. The macrosporangium of Selaginella with its four contained macrospores is maintained to be a homologue of the ovule of Rosa or of Casuarina, and with very good reason too. And a whole sorus in Marsilia including both kinds of sporangia or a megasorus of Salvinia or still more closely a unisporangiate megasorus in Azolla might be maintained as homologous with an ovule. Whoever heard of any botanist homologizing the female prothallium of Selaginella with an ovule? This structure is often homologized with the endosperm of the coniferous or cycadeous seed and I think with propriety, but never in all my reading have I heard of its being homologized with an ovule. Such setting up and solemnly knocking down of morphological straw-men is a reprehensible practice. It becomes doubly so when a writer after knocking down his unrecognizable dummy tells us that it bore the theory of evolution about its garments.

p. 84. "The nucellus of the ovule arises in many instances (*e. g.* in orchids) from a mass of tissue produced by the division of a single epidermal cell." This is based on Hofmeister's statement, but I believe it is contradicted by later research.

p. 401. "Pollination is only the prelude to the phenomenon known as fertilization. It is important to distinguish clearly between these two events."

Comment. Here the proper view of pollination is presented, but no withdrawal of the statement that flowering plants are "air-fertilized" while flowerless plants are "water-fertilized." Indeed (p. 71, bottom and 72, top) it is expressly stated that the reason cryptogams lack blossoms is because these are not needed for aquatic fertilization, while they are for air-fertilization, hence are developed by flowering plants.

In general the pages 401–427 in which the true fertilization, or, better, fecundation, of the metaspermic egg is considered do not connect with the earlier chapters. This is due to the careful rewriting of the latter part, by the editor, I presume. At any rate it reads differently enough from the German original where the same mixture of terms goes on from cover to cover.

There are many more of these errors and confusions in the third half volume of the *Natural History of Plants*. I have not time to point them out but may if it seems necessary contribute a series of comments like the above upon other points that might prove dangerous if not turned in the right direction. In general I am compelled to say, after a careful and complete perusal of the *Natural History of Plants*, that while as a popular store-house of botanical facts it is indeed a mine of information to the one who knows gold from pyrites, it is quite unsafe to consider all that glitters, gold. There are a large number of facts in it which "are not so." And second, as an expression of botanical theory I consider it generally sound but here and there insidiously and insistently misleading. To the trained student of botanical science these slips will not prove troublesome but to the less widely informed reader they will be dangerous.

To sum it all up: the work is invaluable to the thoroughly informed botanical teacher or investigator; he can use the good and discard the bad. It is equally to be commended to the general reader who will profit by what is true and excellent and will not be particularly harmed by the faults. There is one class, however, to whom this book would be an almost unmixed evil and that is to the group of young men intending to become professional botanists. If they base their botanical information or speculation upon the *Natural History of Plants* they will in several important phases of the science find themselves badly confused and misinformed.

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Noteworthy anatomical and physiological researches.

Researches on transpiration and assimilation.[1]

I. *Transpiration experiments.*

Stahl's purpose in writing the paper here reviewed was mainly to present a method by means of which it could be demonstrated to the eye whether a plant loses water by transpiration, and through what parts of its surface the loss takes place. The method does not take the place of weighing the loss of water for all the more accurate experiments. It is valuable on account of its simplicity and the facility it offers for public demonstration coupled with the fact that by it certain problems can be investigated which are not possible by other methods.

Marget[2] was probably the first investigator who used the method about to be described. According to Stahl he impregnated white paper with a mixture of mercurous chloride and pallidous chloride, and also with pallidous chloride, tartaric acid and ferrous chloride. In the dry state the paper was whitish-yellow, but as it absorbed water it became darker and finally black. When applied to the transpiring surface the loss of water could be estimated by the change in color. The color could be fixed at any point by wetting the paper in ferric chloride.[3] Others who have tried to use Marget's

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[1] Stahl, Ernest. Einige Versuche über Transpiration und Assimilation. Bot. Zeit. **52:** 117–145. *pl. 4.* Jl. 1894.

[2] Marget, A. Sur les fonctions des feuilles. Rôle des stomates dans l'exhalation et dans l'inhalation des vapeurs aqueuses par les feuilles. Comptes-rendus de l'acad. des sc. **87:** 293. 1878.

Recherches sur la transpiration des végétaux et le rôle des feuilles dans ce phénoméne. Annales de la soc. d'Agric. etc. de Lyon **1878:** LXXV–LXXVII.

[3] The first account of this method published by Marget in Annales de la Soc. d'Agric. etc. de Lyon l. c. says that the paper was treated with a solution of pallidous chloride, tartaric acid and ferric chloride, *not ferrous chloride.* The paper was then dried and exposed to light which changed the ferric chloride to ferrous chloride. In this condition the paper when moistened turned darker and finally black as the amount of moisture increased. In the last account, Comptes rendus l. c., he simply says that he used a paper sensitized photochemically with a mixture of pallidous chloride and ferrous chloride. The method of doing this is not given but is probably the same as that given in the first paper. The changes in color are given and also a method of fixing the color at any point by simply soaking the exposed paper in a solution of ferric chloride. It is possible with the corrections here indicated that the method may succeed, though I have not had opportunity to test it. It would certainly have advantages over the cobalt method if it could be used readily. I find no mention in the papers cited of the use of mercurous chloride.

method have failed, probably because it was so briefly described by him. Stahl found a much more satisfactory material in the cobalt salts, especially cobalt chloride.[4] Strips of Swedish filter paper were soaked in from 1–5 per cent. water solution of this salt and then dried. When dry the color varies from a light blue in the 1 per cent. solution to a deeper blue in the stronger solutions. The color fades from very light blue to pink, then white, as the paper becomes moist. The paper impregnated with the stronger solution is best for public demonstration but that soaked in the one per cent. solution is best for comparing small differences in evaporation from various parts of the same leaf. A small piece of cobalt paper having been thoroughly dried, is placed on the part of the plant desired, then to hold it firmly against the surface and protect it from the air a thin piece of glass or mica is placed over it and held on with small clamps. After the observation is made the piece may be dried ready for use again.[5]

The author describes a number of experiments with this paper as an indicator which I will briefly summarize.

1. *Stomatic and cuticular transpiration.*—In cases where leaves have stomata only on the under side this side reddens the cobalt paper very quickly, often in a few seconds, while paper on the upper side of the same leaf holds its color often for several hours. The contrast between the upper and under surface is present even in the smallest leaves accessible to treatment, even those still in vernation. Among the plants used are *Syringa vulgaris*, *Cornus stolonifera*, *Ribes alpinum*, *Populus fastigiata*, and *Quercus pedunculata*. Where stomata occur on both sides the reddening of the paper is proportional to the number. In *Trifolium repens*, which has more stomata on the upper than on the under side, the paper faded most rapidly on that side. In the case of slightly wilted

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[4] Cobaltous chloride was used by Marget but abandoned because the change in color passes quickly and can not be fixed. See Annales de la Soc. de Agric. etc. de Lyon l. c.

[5] In using the paper I have found it necessary to exercise caution in regard to several points. Any soft filter paper that takes up moisture readily may be used. Care should be taken to wet the paper evenly with the cobalt. Strips of paper may be dipped in the solutions then laid on blotting paper to absorb the extra solution and dried either in a warm oven or over sulphuric acid. Care must be taken that the cobalt paper is pressed with equal force at all points against the surface to be tested, otherwise the parts most closely pressed against the plant will fade first. This is particularly liable to occur where mica is used to protect the paper from the air.

leaves and in fact in all cases where the stomata were closed on account of an insufficiency of water in the plant even though they were exposed to the sun, no reddening of the paper occurred. This shows how very small the evaporation is through cuticularized epidermis even when exposed to the bright sun. The same was found to be true with fully turgescent leaves supplied with water.

2. *Regulation of transpiration by means of the guard-cells.*—Stahl confirms the observation of Mohl, Leitgeb and others that in the wilting of a leaf the guard-cells are the first to be affected by the loss of water. When two leaves as nearly alike as possible except that one is slightly wilted and has the stomata closed, are placed together between two pieces of glass and the upper surfaces exposed to the bright July sun, the one with the stomata closed gives off no water and wilts no further while the turgid one with open stomata at the start discolors the cobalt paper rapidly and becomes completely wilted. This was found true in all cases investigated, viz., leaves of *Tropaeolum majus*, *Tradescantia zebrina*, *Pharbitis hispida*, *Pelargonium zonale*, *Rhus cotinus*. Rapid wilting also occurs when freshly picked leaves are exposed to bright sun in highly saturated air, while leaves which were first slightly wilted so that their stomata are closed lose no more water when exposed to the sun. Sometimes the stomata would open again in the saturated air and then transpiration would continue.

These experiments show that stomata do not close in saturated air even though the evaporation from the leaf has led to its complete wilting. They further indicate that as the stomata open widest in bright sunlight and saturated air that evaporation under these conditions may be much greater than we expect. Haberlandt's observations on tropical plants[6] (viz., that they lose two or three times less water than plants in Germany) may be even very short of the reality for plants removed from the direct influence of the sun. On the other hand those exposed to the direct sun probably lose more than Haberlandt found. Stahl found that many marsh plants and shrubs in the damp tropical forests are unable to close their stomata. When exposed to dry air they dry up in a few hours. It was also found in these cases that the loss was

[6]Haberlandt, G. Anatomisch-physiologische Untersuchungen über das tropische Laubblatt. Sitzungsb. d. Wiener Akademie **101**: 785–816. O. 1892.

mostly through the stomata. A number of trees inhabiting damp soil were also found to be unable to regulate transpiration, viz., *Betula alba*, *Alnus glutinosa*, and various species of *Salix;* also the shrub *Hydrangea hortensis*, so thoroughly examined by Wiesner.[7]

"The ability to close the stomata, however, under conditions unfavorable for assimilation is surely very common with plants, which in their native locality frequently have to battle with a transient scarcity of water." An hermetic closing of the stomata is especially common with plants whose vegetation is interrupted by long periods of rest. Cobalt tests made October 20th showed a complete closing up of the stomata in *Buxus sempervirens*, *Mahonia aquifolium*, and *Taxus baccata.* They were still open in *Ilex aquifolium* and *Hedera helix.*

Evergreen leaves which have discontinued stomatory transpiration will not redden the cobalt paper even after they have been exposed for a long time in a hot moist room to the sun. For example vigorous branches of Buxus, Mahonia, Ilex, Hedera, and Taxus were cut off in sunny frosty weather Dec. 12th. The cut surfaces were immersed in water and the branches exposed in a moist atmosphere to the sun. The cobalt test after three hours showed a loss of water only in *Ilex aquifolium.* After eight days Taxus and Mahonia began to show loss but Buxus and Hedera still kept their stomata closed. Of all these evergreens, Ilex is the one that suffers first from the cold. Stahl confirms the earlier observations that in colored autumn leaves the stomata are closed. He agrees with Wiesner that the reduction in transpiration greatly influences the defoliation of deciduous plants.

II. *Role of the stomata in the exchange of gases during assimilation.*

On account of the ease with which the cobalt test shows whether the stomata are open or closed, it is a valuable aid in the study of assimilation and exchange of gases in the plant. Stahl proceeded to throw more light on the question as to whether under the usual conditions occurring in nature there was sufficient exchange of gases through the cuticularized epidermis of land plants to render possible the assimilative activity necessary for their growth.

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[7] Sitzungsber. der Kais. Akad. d. Wiss. in Wien. **96:** 182–214. Je.–D. 1887.

Kreusler[8] has shown the great influence of the amount of water contained in leaves on their assimilative activity. "While a complete saturation of the atmosphere does not in itself seem unfavorable to assimilation, the latter may, on the other hand, be considerably reduced by a dry atmosphere and the subsequent powerful evaporation, long before the leaf loses visibly in turgescence. Although it is well known that starch does not represent the primary product of assimilation[9] still its presence or absence may be used as a good comparative test. It was found that in thase plants which can not close their stomata even after they are quite withered starch was made, viz., in *Rumex aquaticus*, *Caltha palustris*, *Hydrangea hortensis*, and *Calla palustris*. On the other hand leaves with closed stomata made no starch. If the stomata on a turgid leaf are closed with a mixture of one part bleached bees-wax and three parts of cocoa butter (this mixture is perfectly harmless to the leaf, does not melt below 40° C. and is easily washed off with water) no starch will be found. If the upper and not the under side is coated there will be no noticeable decrease in the amount of starch formed. The author concludes that under ordinary conditions the main gas exchange is through the stomata and that through the cuticularized epidermis is very small in comparison. This is true even in very young leaves. When the cuticularized surface is scratched or cut, allowing the entrance of CO_2, starch will be formed by the cells receiving CO_2 through the wound. When the air around the leaves contains about 5 per cent. CO_2 a sufficient amount passes through the cuticularized walls to make a large amount of starch.

III. *Prejudicial effect of an increased amount of salt in the substratum on assimilation.*

Schimper in his work on "the Indo-Malayan strand-flora"[10] pointed out the xerophytic nature of most halophytes or salt marsh plants, and also the fact that the presence of a great amount of salt in the tissue is detrimental to assimilation.

[8]Kreusler, Ueber eine Methode zur Beobachtung der Assimilation und Athmung der Pflanzen und einige diese Vorgänge beeinflussende Momente. Tagebl. der Naturforscher-Versammlung zu Strassburg **1885**: 539.

[9]Brown & Morris, A contribution to the chemistry and physiology of foliage leaves. Jour. Chem. Soc. Transactions London **63**: 604–677. 1893.

[10]Schimper, A. F. W., Botanische Mittheilungen aus den Tropen. Die Indo-Malayische Strandflora. Heft 3. 1891.

He considers the reduced transpiration as a guard against excessive accumulation of salt. Stahl goes on with the work for non-halophytes where Schimper left it. He cultivated corn plants in normal solutions with and without 5 per cent. solution of cooking salt; also plants in soil, some watered with the salt solution and others with well water. In all cases he found that the plants given the salt solution stopped developing in a few days, while control plants kept on developing. It was found that there was no starch or sugar present in the plants watered with salt solution while it was plentiful in the others. In a few hours after watering with salt solution the stomata were closed, and the cobalt test showed very little evaporation, even in sunlight. When these plants with the stomata closed were exposed to an atmosphere containing several per cent. of CO_2 they were able to make starch. The presence of sodium chloride in any part of the plant may be demonstrated (according to Schimper) by the use of a saturated aqueous solution of thallium sulphate on tissues freed from air. Crystals of chlorothallium will appear in cells containing the salt. The crystals are black by reflected light. In this way Stahl found that the sodium chloride passes into the epidermal cells but not into the guard cells of the stomata. This, of course, explains their closing.

Leaves of *Alisma Plantago*, *Menyanthes trifoliata*, and *Lilium candidum* were allowed to absorb thallium sulphate (which does not cause the closing of the stomata for some time at least). After allowing transpiration to go on for some time, the chlorothallium was precipitated with calcium chloride. It appears first and most strongly in the guard cells, showing, as Stahl thinks, that there is a current of water in this direction caused by the loss from the guard cells. Later the salt appears in the other epidermal cells also.

Now in regard to the halophytes, it is well known that they thrive perfectly even with large amounts of salt in their tissues. The reason for this as far as the cells themselves are concerned is not clear. Schimper pointed out the xerophytic nature of the halophytes which have the most heterogeneous arrangements for the reduction of transpiration. Stahl shows, however, that these plants do lose large amounts of water and that all these arrangements for the reduction of transpiration are as far as possible to take the place of the lack of the power to close the stomata, so common in marsh plants. In this case, Stahl considers that the staying open on the part of the stomata has to be accepted as a "necessary evil" in order to grow in a substratum that renders the development of other plants impossible on account of the closing of the stomata due to the salt.

IV. *Closing remarks.*

The closing remarks of the paper are especially interesting because they give more clearly the author's ideas on several important questions.

He points out in the first place that the power to open and close the stomata has been of great value in the evolution of plants, in that it gives them the power to grow in a much wider moisture range. Those which have not this power can grow only in extremely moist places.

He goes on to say that the fact that transpiration represents a usual accompaniment of assimilation has been understood in different ways. Some look upon it as a necessary evil, while others (especially following Sachs) recognize in it an important physiological function, whose significance lies in the fact that it enables a continuous supply of water containing mineral nutriments, to reach the assimilating cells.

The opposite opinion has been expressed in a most emphatic manner by Volkens and is based (in his case) on the astonishingly many sided arrangements for the protection of desert plants against loss of water.

In support of the first idea Stahl states that in numerous domestic and especially tropical plants, various arrangements exist which can be explained in no other way than that they are used in transpiration. Many plants are, of course, able to rid themselves of an excess of water in some other way, as by water pores; but still there are many which have no water pores. Here it is transpiration alone which carries off the water from the leaves and makes room for a fresh supply containing nutritive substances. He thinks the importance of transpiration may also depend on the fact that it promotes the distribution of mineral nutrients. He agrees with Sachs's sentence that "the organization of the land plants is only comprehensible when we bear in mind the indicated purpose of the water stream." While in the desert and prairie plants, there are many water-saving devices, on the other hand, in the shade plants and those growing in the dampest tropical countries there are modifications, according to the author, "that only become comprehensible to us when we sufficiently value the great importance of transpiration."

The first of these is the spongy parenchyma, which is especially fully developed in plants growing in moist, shady places and in the dampest tropical countries. The many branched cells, bordering on large intercellular spaces, facilitate evaporation. *Polypodium setigerum* is a good example of a tropical plant of this kind. It is made up almost entirely of spongy parenchyma, bordering on very large intercellular spaces.

In his article on rain fall and the shape of leaves,[11] Stahl concludes that the principal use of the draining of the leaf surface was to promote transpiration. The author promises another paper containing more complete discussion of the adaptations for transpiration.

In this connection I will call attention to what Dr. H. Schenck[12] has to say in regard to the development of spongy parenchyma in shade and especially in water plants. He does not consider it in any way as a means of facilitating transpiration, but on account of the less intense light it is necessary in order to increase the surface as well as the number of working cells which may be exposed to CO_2. This latter view it seems to me is most probably the true one.

Although Stahl holds firmly to the notion that transpiration is of great physiological value to the plant, yet the facts which he has observed may be readily interpreted the other way. In spite of some uncomplimentary things which have been said about this paper by a foreign reviewer,[13] it is one of the most suggestive and helpful articles on transpiration which has appeared for several years.—ALBERT F. WOODS.

[11] Stahl, E., Regenfall und Blattgestalt. Annales du jardin botanique de Buitenzorg 11: 98–182. *pl. 5–12.* 1893.

[12] Die Biologie der Wassergewächse 7–9. Bonn, 1886.

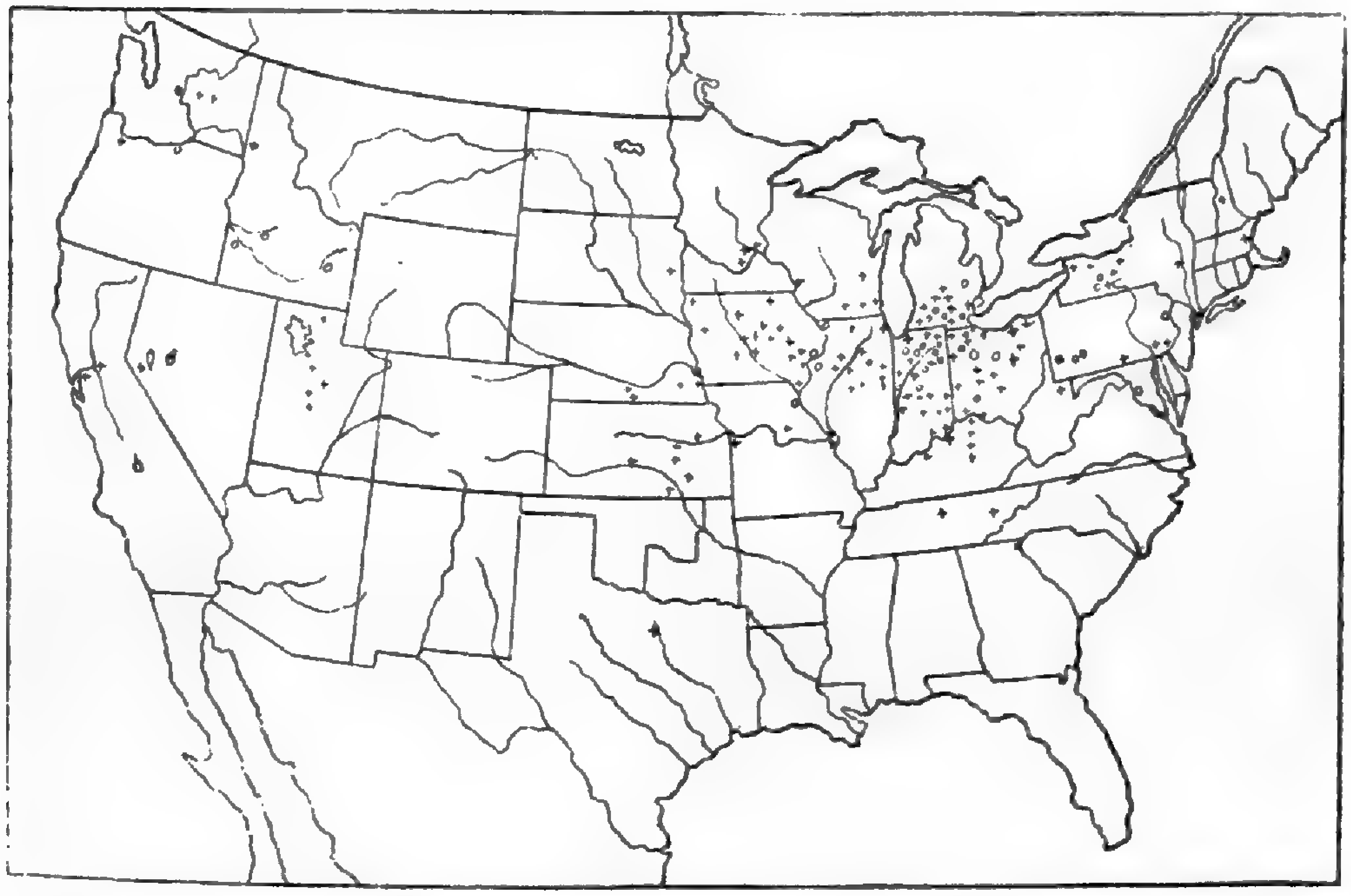
[13] Jensen, H., Botan. Litteraturblade —: 149–152. 1894. [Copenhagen.]

BRIEFER ARTICLES.

Distribution of prickly lettuce in the United States.—Among the weeds of recent introduction in America the prickly lettuce, *Lactuca Scariola*, ranks next to the Russian thistle in the rapidity with which it has spread to new localities and in the completeness with which it has occupied the area infested. Its range almost equals that of the Russian thistle, extending from ocean to ocean, and from southern Minnesota to northern Texas. It is most abundant in the region from western New York to eastern Iowa. There is a wide area from Montana to Mexico, including the Rocky Mountains and the western plains, from which it has not been reported. It is present in the Great Basin in Utah, Idaho, and Nevada, and west of the Cascades and Sierras in Oregon and California.

The first record that we have of the presence of this plant in America is a specimen now in the Harvard herbarium collected at Cambridge, Massachusetts, in 1863. In the fifth edition of Gray's Manual (1867) it is said to be found in "waste grounds and roadsides, Cambridge, Mass." Aside from this there appears to be no farther record of it until 1877, when it was collected in St. Louis, Missouri. From 1878 to 1883 it was reported from at least twenty-two localities in states bordering on the great lakes, many of these reports appearing in the GAZETTE for those years. It was introduced in Salt Lake City as early as 1880. During the subsequent decade comparatively little was written about it. In 1894, however, it became so abundant as to attract attention in many parts of the country. Hundreds of requests for the identification of this species were received by the experiment stations and by the U. S. Department of Agriculture. Surviving in spite of the dry weather which prevented other vegetation from growing, the prickly lettuce became the most abundant and conspicuous of weeds in many places where it had never been noticed before. The alarm caused by the prickly lettuce in 1894, was due in part, doubtless, to the fact that it was often mistaken for the Russian thistle. During the season of 1895, just past, both the prickly lettuce and the Russian thistle have been better known and less has been heard from either of them, although the practical work of destroying them has been carried on with more vigor than ever.

In some localities the prickly lettuce is less prominent than it was last year. Instances are known where a few plants were noticed the first year; the following year they were abundant and large; the third year they were very abundant and smaller; the fourth year other vegetation began to choke them out. Insect or fungus enemies may have aided in subduing them, but there are no observations confirming this theory.



The accompanying map indicates the localities in which prickly lettuce has been found, so far as known to the writer at the present time, October 30, 1895. The circles represent localities from which specimens have been examined. The crosses represent reports of localities not yet confirmed by specimens.

This note is published for the sake of obtaining further information about the distribution of the plant; therefore, botanists and others whose attention may be called to it are specially requested to forward to the writer information regarding other localities where it has been found, or where it has been introduced and afterward exterminated.—LYSTER H. DEWEY, *Washington, D. C.*

A curious coincidence.—The leaves of several India rubber plants (*Ficus elastica*), growing in the Massachusetts Agricultural College greenhouses, are considerably disfigured by the attacks of *Leptostromella elastica* Ellis. This fungus produces large, ashy grey, dark-bordered spots on the leaves, of a definite and usually oval or elongated form. On these light colored areas the perithecia break out in minute black dots. The effect is very noticeable on the dark green leaves and would seem to be most characteristic and unmistakable. When therefore I observed in the same house a leaf of a banyan (*Ficus religiosus*) spotted in precisely the same manner, so far as could be seen with the naked eye, there seemed to be little doubt that the disease had spread from the one species of Ficus to the other. The leaf in question was disfigured by the characteristic light colored, dead area surrounded by a dark border and dotted over with apparent perithecia. Microscopic examination however showed that these were not perithecia of Leptostromella but were clusters of hyphæ and spores of a species of *Macrosporium.* Farther investigation showed that the spot on the leaf was probably a burn, as greenhouse plants are often burned in a similar way by the heating pipes and by the sun. The spots caused by Leptostromella look very much like such burns. On this dead area the macrosporium developed in many minute clusters and thus produced a remarkably exact imitation.—Ralph E. Smith, *Amherst, Mass.*

Two new species of Idaho plants.—Dr. J. H. Sandberg, in 1892, collected two rosaceous plants quite distinct from all their near relatives; one a *Fragaria*, the other a *Rosa.* The generic characters are so pronounced and so well-known by all botanists that it is superfluous to enter into long detailed descriptions.

Fragaria Helleri, n. sp.—Aspect and leaves of *F. vesca*, but flowering stems weak, 1 to 2^{dm} long: the large light rose-colored flowers 1.5 to 2^{cm} in diameter nodding on curved pedicels: scattered hairs among the superficial achenes: ripe fruit not collected.

Rosa Macdougali, n. sp.—Stem with few epidermal spines or frequently none: infrastipular thorns none: leaves and size of flowers nearly as in *R. lucida:* flowers solitary at the ends of short leafy branches: fruits densely spiny.—By the last character this plant is at once distinguished from all other North American roses.—John M. Holzinger, *Winona, Minn.*

CURRENT LITERATURE.

Natural History of Plants.

The completion of Oliver's translation of Kerner's "Natural History of Plants"[1] has been very prompt, and continues the excellent typographical work and illustrations of the preceding parts, which have been reviewed in this journal (20: 327.) The subjects treated in the present parts are styled "the genesis of plant offspring," and "the history of species." Under the latter title the subdivisions are "the nature of species," "alternation in the form of species," "the origin of species," "the distribution of species" and "the extinction of species." These broad subjects are treated in the author's usual interesting style, and a large amount of useful information is brought together. In the first part of the second volume, however, in considering the subject of fertilization and fruit production, we are treated to several surprises. The author is very full of pleasant information concerning the general subject of pollination, and treats it with a fullness apparently out of all proportion to the other subjects, but of this we do not complain, for Kerner is at his best when treating of ecological subjects. But when fertilization and the fruit are considered[2] the first impression is that the ancient date of the German text has to do with the presentation. Such is not the case, however, for so recent a thing as chalazogamy is discussed, and a closing chapter on alternation of generations is modern and proper enough; so different, in fact, from the body of the work, that it seems as if written by an entirely different author. Where the organs and processes of reproduction are spoken of in detail, there seems to be no conception of recent morphology; in fact the phanerogams and cryptogams stand wholly unrelated; the pollen grain contains the "fertilizing substance" and is the equivalent of the antheridium; the ovule finds its morphological equivalent in a bud; the male fertilizing substance passes by osmosis to the "ooplasm;" and so on. The term "fruit" is not that of ordinary usage. It is defined as "a structure which is the product of fertilization, and at the same time constitutes the first step towards the renewal of the fertilized plant." At the same time the term archegonium is discarded and

[1] Kerner von Marilaun, Anton: The natural history of plants, their forms, growth, reproduction, and distribution. From the German by F. W. Oliver. Vol. II. Roy. 8° pp. iv + 983. *pl. 9–16. figs. 189–482.* New York: Henry Holt & Co., 1895. $7.50.

[2] See also on this part Professor MacMillan's criticisms, p. 20. The reviewer wrote entirely without knowledge of this paper.—Eds.

"fruit-rudiment" or "amphigonium" used in its stead, antheridia and fruit-rudiments being the usual association of terms. The archegonium, that is "fruit-rudiment," is said to be a multicellular sheath about the oogonium, and still it is the fruit-rudiment that is fertilized and develops into the fruit. It seems that the "fruit" of moss, which is the embyro of the sporogonium, develops "brood-cells" (the spores), and yet "it is best to look upon the formation of fruit as being complete as soon as fertilization has taken place; from this moment the ooplasm must be considered to be an embryo, and its envelopes to be fruit coats." Just what the conception of "fruit" is in the author's mind the reviewer has failed to discover. "The tissue produced from a macrospore in the *Selaginellæ* has been compared to the ovule as it occurs in the phanerogams" is certainly a curious statement, as also "these two (polar nuclei) approach one another at about the moment of fertilization." Evidently the author has a theory of fertilization and fruit formation to work out, but it is so at variance with our current notions of morphology that it seems to result in utter confusion. How such a presentation is made consistent with a short account of alternation of generation given at the close of the volume is inexplicable. In this account the cumbrous ideas and terminology are abandoned and archegonium, gametophyte, and sporophyte appear in logical order throughout the whole series of plants, including the phanerogams. In his preface to the chapters on reproduction the author assures us that "hitherto the subjects of fruit-formation and of the alternation of generations in their relation to the history of plants have remained unrecognized and unelucidated. In one of the following sections of this volume an attempt will be made to solve this great mystery."

In spite of the strange presentation of fertilization, the book remains, as was stated in the outset, a most valuable summary of ecological facts and a model of interesting style in presentation.

Minor Notices.

THE MOST RECENT "Contribution" from the Botanical Division of the Department of Agriculture contains a report by John M. Coulter and J. N. Rose upon Mexican Umbelliferæ, mostly from Oaxaca, being based upon collections of C. G. Pringle and E. W. Nelson. Special attention was given to the group by these collectors, and the result is that Oaxaca has been discovered to contain an unusually rich umbelliferous flora. But ten species had been reported from that state, while the collections of Pringle and Nelson contain forty-two species, twenty-three of which are new. Among the new species, four new genera are represented, although two of them (*Neogoezia* Hemsley and *Deanea* Coulter & Rose) have been published in anticipation of the present contribution. The other two are named *Neonelsonia* and *Coaxana*. Species outside of Oaxaca bring up the number of new ones described to twenty-seven. Altogether, this forms the most valuable contribution to our knowledge of Mexican Umbelliferæ.

In addition to descriptions of new genera and species, and critical notes upon the other species collected, there is a somewhat detailed account of the topography of the stations explored, and a revision of *Museniopsis*, a genus now far better understood, and containing at least eleven species, the Mexican forms heretofore referred to *Eulophus* being included.

A second part of the "Contribution" is by Mr. Rose, who presents new or noteworthy plants from Mexico and the United States, including descriptions by Baker fil. and Cogniaux. The contribution also contains twelve plates.

An excellent experimental and critical study of some of the fungi parasitic upon insects has been made by Mr. Rufus H. Pettit,[1] of Cornell University. The material for the study was largely found in the vicinity of Ithaca, N. Y., and yielded a number of new forms and species. In all cases the fungus was transferred from the insect on which it was found to nutrient media. Several media were used, but more especially agar and potato. The forms studied were *Cordyceps clavulata* (Schw), Ellis on scale insects of the genus Lecanora *C. militaris* (L.) Lk., *C. melolonthæ* (Tul.) Sacc. on a white grub, the larva of the Lachnosterna, *Isaria farinosa* (Dicks.) Fr. on an arctiid cocoon, *I. tenuipes* Peck on pupæ of species of arctiids, *I. anisopliæ Americana* n. var. on wireworms, Agriotes mancus, *I. anisopliæ* (Metch.) received from France, *I. densa* (Lk.) Fr., also from France, *I. vexans* n. sp., on a larva of Lachnosterna, *Sporotrichum globuliferum* Speg. on a carabid beetle, on chinch-bug and on a vespa, and *S. minimum* Speg. on a black ant of the genus Camponotus. A bibliography of 76 numbers is appended. Eleven good plates illustrate the gross and minute structure of the fungi, and the appearance of the artificial cultures. The paper is a valuable contribution to our knowledge of insect parasites and to the possibility of using them to arrest their destructive increase.

A contribution from the National Herbarium, just published, presents a report on a collection of plants made by J. H. Sandburg and assistants in northern Idaho in 1892. The determinations have been

[1] Pettit, Rufus H.—Studies in artificial cultures of entomogenous fungi. Bull. Cornell Exper. Station. 97: 339-378. pl. 1-11. July, 1895.

made by Mr. John Holzinger, assisted by specialists in various groups. The region of northern Idaho is one of great botanical interest and has been of late years contributing many novelties. A few species are described, not so many perhaps as were expected, but many of the plants are of great interest. As a matter of nomenclature it may be worth while mentioning a new Cardamine which is described as *C. Leibergii* and figured as *C. Sandbergii*. Just which of these names has the "right of way" may be a question.

THE FOURTH PART of John Donnell Smith's "Enumeration of Guatemalan Plants" has been issued. In this enumeration not only are Guatemalan plants included, but also numbers from other republics of Central America. The list is printed to accompany the distribution of sets, and represents the work of several American and European botanists. Following the list are reprints of these descriptions and thirteen Meisel plates. Captain Smith cannot be too strongly commended for his vigorous development of our knowledge of Central American plants, to which he contributes largely of his time and means.

OPEN LETTERS.

Terminology of the inflorescence of grasses.

One of your correspondents, in the December number of the BOTANICAL GAZETTE, objects to the terminology adopted in my paper on grasses which appeared in the October issue of the *Bulletin* of the Torrey Botanical Club. He says I have "changed the definite and well-known terms, 'glume' and 'palet', to the very loose and indefinite word 'scale.'" He has, however, misrepresented my application of the term scale, for while I did use it in referring to the glumes, in no instance have I employed it in connection with the palet, being well "aware of the morphological dissimilarity of these organs." In the paper referred to I had no occasion to allude to the palet, so that I cannot understand on what grounds the assertion is based. In my paper on "New or Noteworthy American Grasses" in the November number of the *Bulletin* it was necessary to describe this organ and I alluded to it as the palet, as a reference to page 463 of that periodical will show.

Your correspondent displays ignorance when he says "the term 'scale' is used to designate the *flat* imbricate bracts in inflorescences of various families, e. g., Cyperaceæ, Xyrideæ, Compositæ, etc." While the scales in Cyperus, a by no means small genus, are imbricated, as is also the case in grasses, they could hardly be called flat; they are actually carinate and nerved, as in Gramineæ. They are rounded and keeled in many other sedge genera. They are concave in Xyris, and largely so in Compositæ. Neither are all grass scales carinate, but a large number are rounded. There can be no possible objection to calling these organs glumes if any one desires to do so.—GEO. V. NASH, *Washington, D. C.*

Mimicry of fungi in insects.

Professor Farlow[1] has evidently overlooked the description of the mimicry of fungus spots on the wings of Kallima which is given by Wallace in "Darwinism", pages 207 and 208. Although he does not name the fungus imitated, he gives the essential facts as stated by Dr. Farlow.—R.

[1]BOT. GAZ. **20**: 547. 1895.

NOTES AND NEWS.

DR. G. LAGERHEIM of the Botanical Museum of Tromsö, Norway, has been made professor of botany, and director of the Botanical Institute of the University of Stockholm, Sweden.

MR. GEORGE HALEY writes us that he has discovered *Lycopodium alpinum sabinaefolium* at Chatham, N. H., alt. 3,500ft, and inquires whether any other station has been reported for it in the United States.

MR. GEO. E. DAVENPORT asks us to say that the story[1] of Prof. D. C. Eaton having been led to interest himself in ferns through the young lady who afterward became his wife is untrue, as he learns from Mrs. Eaton herself.

PROF. GEORGE LAWSON of Dalhousie College, Halifax, N. S., died Nov. 10th. He published many papers upon the flora of the maritime provinces, partly printed in the *Proceedings* of the Royal Society of Canada, of which he was president in 1888.

AT A RECENT meeting of the Linnean Society (Nov. 7th) Mr. C. T. Druery exhibited a specimen of Scolopendrium bearing antheridia and archegonia upon the fronds, said to "constitute a more advanced phase of apospory than any previously noted."

A WISCONSIN correspondent of *Garden and Forest* (Nov. 27th) gives some details as to the supposed poisoning of horses by Solidago. The case is not proved against Solidago, but the genus is under suspicion. As to the species suspected there is no intimation.

PROFESSOR E. L. GREENE has determined the dates of issue of Nuttall's Compositæ, a matter of considerable importance in matters of priority. He publishes his results in *Erythea* (Dec.) as follows: pages 283 to 356 were published in 1840; pages 357 to 455, in 1841.

THE LAST INSTALLMENT of Jennan's synoptical list of the ferns of Jamaica (Bull. Bot. Dept. Jamaica **3**: 266–270) includes *Aspidium macronatum pinnatifidum, A. triangulatum* Sw. in three forms, *A. tridens* Hook., *A. viviparum* Hook., in several forms, *A. aculeatum* Sw. and *A. acul. Moritzianum.*

THE SPOT DISEASE of orchids, which disfigures the leaves, has been studied by George Massee (*Ann. Bot.* **9**: 421), and found to be due to small drops of water on the leaves at the time when the plants are chilled. The histological appearances resemble those caused by the so-called Plasmodiophora of the grape.

MR. A. A. HELLER has just returned from a nine months collecting tour in the Sandwich Islands. Nearly the entire period was spent on the islands of Kauai and Oahu. His collection contains thirty thou-

[1] See his sketch of the life of Prof. D. C. Eaton in this journal. **20:** 366. 1895.

sand specimens and includes about one thousand numbers. At least a score of new species have been secured.

MR. BRUCE FINK has published (Bull. Lab. Nat. Hist. State Univ. Iowa) a list of Iowa lichens, the first attempt, so far as we know, to enumerate the lichen flora of the state. Some interesting generalizations are also made, such as: "Of the 196 forms listed, 92 were found only on wood, 57 only on rocks, 2 on wood and earth, and 3 on rocks and earth."

BOTANISTS will be gratified to learn that a supplement to the *Index Kewensis* is in preparation, covering the decade following 1885. The basis of it has been prepared by M. Th. Durand, who with Mr. Daydon Jackson is pushing it to completion. The *Kew Bulletin* (Nov.) announces that "it is hoped that they will be able to publish during the course of the next year."

THE JOURNAL OF BOTANY proposes to enlarge, provided sufficient financial support can be secured. The size will be increased sixteen pages and the subscription price to 16s. Increase in the number of papers for publication has rendered the enlargement necessary. It is to be hoped that the needed encouragement will be obtained from British botanists, and the GAZETTE sends its best wishes to its trans-Atlantic colleague.

DR. H. MARSHALL WARD, professor of botany in the Indian Engineering College, has been elected professor of botany in the University of Cambridge. Dr. Ward's admirable researches on the coffee-disease of Ceylon, the root tubercles of leguminous plants, the action of light on bacteria, etc., have made his reputation world wide, and American botanists will be glad to know that the botanical department at Cambridge is to have a vigorous head.

THE BARTRAM BOTANIC GARDEN in Philadelphia, possibly the oldest one in this country, and certainly the most famous, has recently been placed in charge of the botanical department of the University of Pennsylvania. It has already been considerably renovated and extended by Professor Macfarlane. The garden became a part of the system of city parks some time since, and all financial responsibility, as well as the general care and protection of the grounds, rests with the park commissioners.

THREE GARDEN scholarships in the Missouri Botanic Garden will be awarded by the Director of the Garden, prior to the first of April next. One of these scholarships is at the disposal of the St. Louis Florists' Club, and applicants for it should address the Secretary of the Club, enclosing references and stating their qualifications. Applications for the other two scholarships, to receive consideration, must be in the hands of the Director not later than the first day of March. Further information may be obtained of the Director, Dr. William Trelease, St. Louis.

THE NEW RANGE of greenhouses in the botanic garden of Smith College has just been completed. It includes an experimental house with workroom attached, and cool temperate, succulent, warm temperate, stove, palm and propagating houses. The experimental house will be equipped with needful appliances for physiological and biological study and investigation, and the other houses will be stocked with plants which are primarily of educational value and interest. The range has been built in the most substantial manner, with all modern improvements. Smith College is thus well provided with the essentials for the furthering of this part of her botanical work.

Mr. D. Prain's studies in Argemone are continued in the *Journal of Botany* and the December number deals with forms of great interest to American botanists, those which have become familiar to us under the names *A. Mexicana* and *A. platyceras*. That there has been utter confusion in regard to them American botanists have long been willing to testify, and if Mr. Prain has succeeded in disentangling them he has done us good service. He finds two types, *A. intermedia* Sweet and *A. platyceras* Link & Otto, the former with one variety, *stenopetala*, the latter with two, *hispida* and *chilensis*. It is surprising to note the indiscriminate reference that has been made in previous publications.

The appearance of "Chichi," or nipples on old trees of Ginkgo lobata, the maidenhair tree, is described by Kenjiro Fujii (*Tokyo Bot. Mag.*, **9**: 440–444) and illustrated by a photogravure plate of a part of an old tree near a Japanese temple. The nipples are woody outgrowths, which drop vertically downwards from the branches, and remind one of the upward growing "knees" of cypress trees. The author likens them to stalactites, which would lead us to liken the "knees" of cypress to stalagmites. Their morphology has been only partially worked out, but they appear to be associated with latent adventitious buds. A further communication on their structure is promised. Nothing is said of their physiological significance, which can not fail to be of much interest.

Dr. S. Nawaschin has given a detailed account of the structure of the sexual organs in *Betula*, and the process of fertilization. He regards chalazogamy as one of the intermediate stages between the intercellular growth of the pollen-tube in the gymnospermous ovary, and its free growth through the cavity of the ovary in angiosperms. The first adaptation to the penetration of the pollen-tube through the chalaza lies in the formation of lateral ovules. In plants with a single terminal ovule chalazogamy is impossible. The author traces the development of the typical angiospermous ovary through the following stages: (1) An open ovary, as in Coniferæ, with central ovule consisting of nothing but nucellus; (2) closing of the mouth of the ovary (unknown); (3) the ovule clothes itself with an integument, as in *Juglans* and *Myrica*, porogamy; (4) central placenta with two naked ovules, *Loranthus*; (5) *Alnus*; (6) *Betula*; (7) *Ulmus*, an intermediate condition between porogamy and chalazogamy; (8) typical angiosperms. In the development of dicotyledons two lines of descent have manifested themselves,—one, the Acrospermæ, begins with a simple porogamous mode of impregnation; while the other series, the Pleurospermæ, have begun with chalazogamy, becoming afterwards porogamous. The apetalous dicotyledons are probably descended from the Coniferæ; the Casuarineæ from the Gnetaceæ; the monocotyledons from the Cycadeæ.

BOTANICAL GAZETTE

FEBRUARY, 1896.

Contributions from the Cryptogamic Laboratory of Harvard University. XXX.

New or peculiar aquatic fungi. 3. Blastocladia.

ROLAND THAXTER.

WITH PLATE III.

In the two preceding notes on aquatic fungi reference has several times been made to a paper by Reinsch[1] in which, among other interesting forms, he describes the curious genus *Blastocladia;* including the single species *B. Pringsheimii,* which, as far as the writer is aware, has not been again observed. The genus has since been wholly ignored by systematists or placed among the doubtful Saprolegnieæ. Fischer in his Phycomycetes[2] includes it among the genera of this group which are doubtful or to be excluded, while Schroeter in his more recent revision[3] finds a place for it among the Leptomitaceæ; on the ground that, although lacking the segmentation so characteristic of this order, it corresponds in general habit to the species of the genus Rhipidium, as was formerly pointed out by Cornu.[4] The uncertainties which have surrounded it have been in part due to a lack of exact knowledge concerning it, and in part to the truly anomalous character of the plant itself, which occupies a distinctly isolated position among other aquatic Phycomycetes.

Notwithstanding the fact that it has remained unknown for twenty years since its original discovery, it has proved in the writer's experience to be one of the more common aquatic fungi, occurring in almost every locality where it has been

[1]Pringsheim's Jahrb. f. wiss. Bot. **11**: 291. 1876.
[2]Rabenh. Kryptogamenfl. **1**⁴: 367. 1892.
[3]Engler & Prantl Nat. Pflanzenfam. 93: 103. 1893. [I Th., 1 Abth.].
[4]Bull. Bot. Soc. de France **24**: 227. 1877.

sought for, both in the vicinity of Cambridge and of Kittery Point, Maine. The present note therefore is based on the examination of very abundant material from widely separated localities, which illustrates by an almost unbroken series the wide range of variation for which this plant is remarkable.

In general terms the fungus may be described as consisting of a highly developed unicellular main axis ("Hauptstamm") more or less clearly differentiated, which may remain simple or become distally variously branched, and is attached by copious rhizoids to the substratum on which it grows. The branching of this axis may be sub-umbellate or irregularly dichotomous, while the branches themselves may be in turn several times more or less irregularly branched, varying greatly in size, habit and appearance. The axis if it is simple, or its ultimate branches when it is otherwise, become as a rule more or less abruptly swollen distally into often well developed heads from the surface of which are produced, terminally or sub-terminally, the organs of reproduction, as well as certain peculiar sterile branchlets which will be mentioned subsequently. In some branched forms, however, this terminal swelling is not noticeable, the reproductive organs being borne singly at the tips of short ultimate branchlets (fig. 6). Apart from these organs which are separated from it by septa, the plant consists, as has been just mentioned, of a single cell, in the contents of which certain spherical oily masses, very variable in size, are usually conspicuous (figs. 1 and 3). These masses, which are sometimes wholly absent, were described by Reinsch[5] as independent cells endogenously formed, at first free in the protoplasmic contents and later giving rise to the reproductive organs. After fixing themselves to the inner surface of the wall of the terminal enlargement of the axis already mentioned, they were said to burst through to the outside and develop into sporangia, "oospores" or "antheridia?" according to circumstances. In fresh material these bodies resemble homogeneous refractive oil globules; but when stained they seem to consist of a coherent mass of coarse granules, having the appearance represented in fig. 3. In his examination of these bodies, however, the writer has seen nothing which would indicate the

[5] "Diese Zellchen legen sich an die innere Schlauchwandung an, durchbrechen —von der Beruhrungsstelle mit der Schlauchwandung auswachsend—die Membran des Schlauches und kommen auf der Aussenseite der Schlauchwandung als kleine Hökerschen zum Vorschein."—Reinsch l. c. 292.

truth of this, in itself improbable, supposition of Reinsch. Although they are somewhat peculiar from the fact that they stain readily, and permanently retain their form and characteristic appearance after the plant has been crushed and its contents scattered in the surrounding medium, there seems no ground for the belief that they are anything more than masses of fatty protoplasm, as would naturally be inferred from the fact that they may be present or absent according to the character of the nutrient substratum. The variation in size of such masses in a given individual is usually extreme, some appearing as mere minute granules, while others nearly fill the terminal heads. In no instance, moreover, has the writer seen one which seemed in any way to connect itself with the formation of one of the buds which develop into reproductive organs.

The zoosporangia first make their appearance as papillæ formed at or near the extremity of the axis or of its branches, which are soon cut off by septa as independent cells (fig. 4, at the left) and soon increase in size, assuming the form characteristic of the mature sporangia. The latter vary very greatly in shape and size, so that any one who chanced to find the extremes of variation without knowledge of intermediate forms would hardly hesitate to separate such varieties as distinct species; especially in view of the fact that variations in the sporangia are often associated with differences almost as extreme in the form and size of the resting spores as well as in the general habit of the main axis. From slender elongate nearly cylindrical zoosporangia (fig. 2) to much shorter and stouter (fig. 3) or even broadly oval forms, every gradation may be found; but in a given individual there is usually a general uniformity in their size and shape. They are formed in considerable numbers on a given tip, usually at its summit; but sometimes also in small numbers laterally below it, and when mature the contents divide into a very large number of zoospores, while a thickened papilla of dehiscence is formed at the apex (fig. 10). Finally this papilla, as it begins to deliquesce, is pushed off by the mass of zoospores within, and the latter make their escape one by one, swarming almost immediately, The empty sporangium wall eventually disappears, leaving a circular scar where it was attached, and the fertile surface of exhausted plants is thickly studded with such marks.

The zoospores are peculiar in appearance and can readily be distinguished from any similar bodies known to the writer by the characteristic disposition of their contents. In general form they are oval or elliptical and are, at least in many cases, biciliate; the two cilia arising side by side from the smaller end of the spore. In some instances it has been found impossible to make out more than a single cilium even after the zoospore was stained; but the presence of two (fig. 11) has been determined definitely in so many cases that this number may be considered as typical. The nucleus is very large and sub-triangular in outline, its base connected with that of the cilia by a fine strand of granular protoplasm. In front of the nucleus lies a broad and distinct mass of granular protoplasm while small groups of granules occur here and there around it in the otherwise nearly clear cytoplasm. In general appearance they are not unlike the zoospore of Gonapodya, but may always be distinguished by the form and position of the nucleus and the evident connection of the latter with the base of the cilia. As the fungus developes, growing as it almost invariably does in tufts, it forms the center of a dense mass of bacteria which finally choke the sporangia completely; so that as a rule only those first formed are able to discharge their contents. As a result the zoospores commonly die without escaping; the remains of their large nuclei just mentioned filling the sporangia, as is indicated in the central sporangium of fig. 3. These dead nuclei were taken by Reinsch for the zoospores themselves and are represented in his plate XVI, fig. 8.

Associated with the sporangia are often found numerous slender filaments which arise as buds in a fashion exactly similar to that by which the former are produced. They are very slender, simple or irregularly branched, without septa, and often greatly exceed the sporangia in length (fig. 2). In a majority of cases, however, they are wholly absent or undeveloped (fig. 1 at the right) and they seem to bear no definite relation either to the sporangia or to the resting conidia. They seem to be quite sterile and although Reinsch suggests that they may be antheridia they are probably without definite function, and are certainly not male organs.

The resting spores, already referred to, and described by Reinsch as doubtful oospores, do not as a rule make their appearance until some time after the sporangia have been developed; in other words the former are characteristic of the earlier, the latter of the later conditions of the plant. In origin these spores correspond in all respects to the sporangia; arising as buds from the surface of the swollen extremities of the axis from which they are soon separated by a septum. As they mature they usually assume a more or less oval form, become very thick walled and when ripe fall readily from their attachment, leaving a circular scar. The mature spore has two walls, an outer, thin and even, and an inner, thick and curiously modified, so as to present the appearance represented in fig. 12, when viewed in optical section. Whether the characteristic markings figured are really pits, as they appear to be, can hardly be definitely determined without an examination of an absolute section of the wall, and such a section has not been obtained. The surface view of these "pits" is represented by the circular outlines shown in fig. 13. Several large oil globules are usually present in the contents of these resting spores and all attempts to induce them to germinate have proved unsuccessful, although cultures have been continued for more than a month. In form they vary almost as much as the sporangia; being in some cases quite spherical, with a small papilla of attachment as in figs. 8 and 9, in others nearly oval with a broad base as in fig. 7, or long piriform as in fig. 7. There is, however, a notable tendency in a given plant to produce resting spores of a given form even if, as in fig. 8, this form is an unusual one.

As far as can be determined these spores are wholly nonsexual in origin, and the most careful examination has failed to show the presence of anything which could be by any chance interpreted as an antheridium. The absence of any such organ naturally suggested the possibility of the existence of motile antherozoids similar to those found in Monoblepharis; but there is certainly only one kind of sporangium, and even if antherozoids in reality existed, it would be, in almost all cases, quite impossible for them to perform their office from the fact that, by the time the resting spores begin to form, the whole plant is, as has been already mentioned, completely enveloped in a solid mass of bacteria and other organisms which would effectually prevent access to the oogonium, if it were such, by any body dependent on cilia for its motility. The outer wall of the spore, moreover, is always continuous, showing no signs of any perforation or receptive spot.

Among the material collected in one locality near Kittery Point, numerous plants were found bearing peculiar sporangia, proportionately much larger and more nearly oval than the ordinary forms, many of which contained large well defined rounded masses of protoplasm which at first suggested the presence of oospheres; but further examination showed them to be early conditions of the resting spores of a species of Rozella parasitic on the Blastocladia, which, when mature, became spherical, thick walled, and echinulate.

The position of the genus among related forms is very doubtful, and although in habit it resembles Rhipidium, while its zoospores recall those of Gonapodya, there is no reason for believing that it is at all closely related to either of these genera. Its resting spores are in some respects comparable to the deciduous resting conidia of certain species of Pythium, especially in the new form described below, and for lack of any more satisfactory disposition, it may be placed provisionally among the Pythiaceæ; the only alternative being apparently the erection of a special family for its reception.

In addition to the material of *B. Pringsheimii* obtained, a second and much less well defined species was found in company with it in a single locality at Kittery Point. In this form the resting spores are less highly differentiated, though produced in greater abundance, and resemble thick walled sporangia, slightly modified in form. There can however be little doubt of the correctness of the generic reference of the plant, which may be characterized as follows:

Blastocladia ramosa, nov. sp.—Main axis nearly cylindrical, attached to the substratum by rhizoidal divisions of its base; above copiously branched, irregularly or sub-dichotomously, the branchlets producing terminally and sub-terminally sporangia and resting spores. Sporangia broadly oval, bluntly pointed, $30 \times 15\mu$. Resting conidia terminally bluntly rounded gradually narrower towards the truncate base, about $30 \times 11\mu$. The whole plant 260 to 600μ high, its main axis 14 to 20μ in diameter.—On submerged twigs, Kittery Point, Maine. Plate III, figs. 14–16.

This species has been found in only one locality growing with *B. Pringsheimii* and other forms in a small pool in a sphagnum bog, and occurred in such small quantity that I was unable to observe the escape of its zoospores; since, in the material examined, the zoosporangia were comparatively rare. In all cases the resting spores were formed in great profusion and seemed constant in form though somewhat variable in size. Their walls, though usually distinctly thickened, are never as conspicuously so as in the larger species, and might very properly be spoken of as conidia; since, in many instances, even after they are detached, their walls do not appear to be much thicker than those of the sporangia. I have never seen an instance, however, in which one seemed to have discharged its contents like the normal zoosporangia. The species is an insignificant one, and would not have been described without further observation, had it not possessed a certain interest in connection with its more highly developed ally.

For convenience of reference a description of *B. Pringsheimii* is appended, no measurements of this species having been previously published.

BLASTOCLADIA PRINGSHEIMII Reinsch.—Main axis simple or several times successively branched sub-dichotomously sub-umbellately or irregularly, the free extremities usually but not always distally swollen into more or less well defined terminal heads. Reproductive organs, sporangia and non-sexual resting spores, produced terminally and sub-terminally and often associated with slender sterile filaments branched or simple and similarly produced. Sporangia long cylindrical to long oval, more commonly more or less pod-shaped, producing very numerous biciliate zoospores. Resting spores formed like the sporangia, spherical, oval, or long piriform, the wall much thickened and pitted. The whole plant 200 to 750μ in height (exclusive of rhizoids), the larger terminal heads 100–150μ in diameter. Main axis 30–90μ in diameter. Zoosporangia $150\times25\mu$ ($50\times25-225\times18\mu$). Zoospores about $7\times5\mu$. Resting spores 50×30–$75\times44\mu$.—On apples and other decaying vegetable matter in ponds and ditches. Vicinity of Cambridge, Mass., and Kittery Point, Maine. On decaying apples in water, Germany (Reinsch). Plate III, figs. 1–13.

Cambridge, Mass.

Explanation of Plate III.

Blastocladia Pringsheimii Reinsch.

Fig. 1. Single plant of large size showing rhizoids; sub-dichotomously branching axis with fatty bodies in its contents; sporangia, many of which are empty (two discharging zoospores); young resting spores and two sterile branchlets.

Fig. 2. An axis bearing two heads with long cylindrical sporangia, some of them empty, and long sterile branchlets.

Fig. 3. An older simple plant with larger fatty masses and mature resting spores; four of the sporangia empty the other two filled with the nuclei of dead zoospores.

Fig. 4. Mature resting spore *in situ*; at the left a young resting spore just separated as a bud from the surface of the head.

Fig. 5. Mature resting spore, surface view.

Fig. 6. Small plant; the habit and the form of the resting spores unusual.

Fig. 7. A branch of the same enlarged, with single terminal resting spore.

Fig. 8. A plant irregularly branched with spherical resting spores.

Fig. 9. Two resting spores of the same, that at the right seen in optical section.

Fig. 10. Sporangium just before the discharge of zoospores showing papilla.

Fig. 11. A single zoospore.

Fig. 12. Optical section of wall of resting spore.

Fig. 13. Surface view of a portion of wall of resting spore.

Blastocladia ramosa Thaxter.

Fig. 14. General habit of plant.

Fig. 15. A terminal branch with two sporangia (one of them empty) and six resting spores.

Fig. 16. Two resting spores showing relative thickness of wall.

*** Note. The original figures were drawn with the following approximate magnifications in diameters, and have been reduced about one-third by photo-lithography. Figs. 1, 2, 3, 6, 8, 14, × 90. Figs. 4, 5, 7, 9, 15, 16, × 420. Figs. 11, 12, 13, × 925.

Michael Schuck Bebb.

WALTER DEANE.

WITH A PORTRAIT.—PLATE IV.

Once more we are called upon to mourn the loss of one of our leading systematic botanists, Michael Schuck Bebb, a man who in his own specialty stood without a peer, and in whom a gentle refined nature, an enthusiastic pursuit of his favorite study, and scholarly tastes, were joined to a keen and critical mind. He was a true student of nature. Accustomed to an out-of-door life from his earliest years, he acquired a deep love for the world about him and a sharpness of observation that later bore noble fruit when his mind was turned to botanical studies and in particular to the willows.

His early training peculiarly fitted him to deal with a subject that required most careful and patient work both in the field and in the study, and he treated that most difficult genus *Salix* with a master mind. Mr. Bebb won a well-deserved reputation as the leading salicologist of this country and Europe, and his valuable contributions to science will remain as a permanent memorial. Within the past few years our ranks have been sadly depleted by the death of many of the older botanists, men who wrought at the foundations of systematic botany in this country, and to whom the younger generation owes everything. Our friend was one of these. Quietly, unostentatiously, and with unremitting labor he did his work, and with sad but grateful hearts we pay our tribute to his memory.

In the year 1789, Edward Bebb, the grandfather of the subject of our notice. in company with his young bride floated down the Ohio river in a flat-bottomed boat to start their new home in Butler county, southern Ohio. The story of their marriage is a romantic one and deserves special mention. Edward Bebb was a Welshman and, on leaving his old home some years before, to fight his way to success in the new world, he left behind him a young girl, a native of Wales, Margaret Roberts, to whom he was engaged. He intended to return for her later when he had secured a home. There was but little communication between the two countries in those early days, and as some years passed by and Edward Bebb was not heard from, Mr. and Mrs. Roberts thought that he had forgotten their daughter, and she was persuaded to marry a young clergyman.

The newly married couple sailed for America, but on the voyage misfortune came upon them. A cargo of copperas which the ship had taken on a previous trip had poisoned the water, and this unhappy circumstance caused the death of Margaret's husband and many other passengers. When the ship reached Philadelphia, the young widow made her way to her brother's home in Johnstown, Penn., doubtless intending to stay there till she could return to her native country. Meanwhile Edward Bebb, seeing his way clear to return to Wales for the maiden whom he had not seen for so long, had actually started on his way. His route lay through Johnstown, and there the lovers met. They were married, and over a hilly country they walked for eighty miles to Pittsburg, whence they floated down the Ohio river to the home which Edward had been faithfully preparing. For three years he had been a pioneer in the Miami valley, in southwestern Ohio, clearing up his farm and building his two-storied house of hewn logs.

In 1802, William Bebb, one of three children, was born. As a baby he "was often entrusted to the care of the Indian women," belonging to the friendly Miami Indians who had a camp near by, "and swung from a bough with the rest of the pappooses." His early life was spent on the old place. Arrived at manhood he conducted a successful boarding-school, less than a mile from his old home in the same county, and it was during this time that he studied law and was admitted to the bar. He married Sarah, the daughter of Michael Schuck, a German, and by her he had five children, one of whom was Michael Schuck Bebb.

He was born on December 23, 1833, in the school building, and was named for his grandfather. In later years he described his birthplace thus:—"There was a brick building with hallway through the middle, and a broad veranda and kitchen in the rear, for dwelling and boarding-house; a long frame two-story barn-like structure for dormitory, and a separate schoolhouse. Besides, the older boys had log cabins which they built for themselves and to which they could retire for quiet study or for little suppers of their own which were probably not so quiet!"

Shortly after Michael's birth, the school was closed and in 1835 the family moved to Hamilton, the county seat, a few miles distant, where Mr. Bebb wished to practise law. He had already become a very successful lawyer, as was attested by the comfortable house and ample grounds which they now occupied. Here Michael's boyhood was spent, and here began his first love for botany. "The pleasure grounds, vegetable and fruit gardens," he writes, "occupied four acres. There were four acres more of pasture for the horse and cow," and in addition to this four acres of Morus multicaulis with a cocoonery. "The garden was laid out in old-fashioned geometric style; the borders well filled with rare shrubs and perennials, Holland bulbs, and, I am happy to add, native plants as well." If we add to this a well-stocked greenhouse, twenty by one hundred and fifty feet in dimensions, we can readily understand how Michael early acquired a passion for the study of the plants about him.

He attended a private school, did a boy's share of work on the farm and in the garden, and enjoyed the companionship of the head gardener, whose practical talks on horticultural subjects made a great impression upon him. In later years he spoke with great fondness of this time, and he always dwelt very tenderly upon the influence of his mother, "a fair-haired, comely, serene woman, who had almost the entire care of the social, moral and home life of the family of five children." On the occasion of her death in 1892, he writes, "It was the closing of a long and useful life. Two traits in her character were so predominant as to be at once recognized by every one with whom she came into personal relations; first, an unswerving conscientiousness; second, a wonderful placidity of demeanor." It is when we know of such influences as these that we can understand the genial nature and the true love for home and family that were so prominent in Mr. Bebb.

In his father's library in Hamilton were many books on horticulture, more or less botanical in character, but it was through the influence of his uncle, Evan Bebb, a merchant in New York city, that his father received some volumes relating to purely botanical subjects. These were a complete set of the Natural History Reports of the State of New York, which included the two volumes of Torrey's Flora. A little later Emerson's Trees and Shrubs of Massachusetts was added to the collection. Young Bebb seized upon these with avidity, for before this, as he himself says, he did not know that there was such a thing as a text-book or introduction to the study of the science, with a key by which the young student might trace the genera and species, and learn something of their relationship.

Mr. Bebb was about sixteen years old at this time, and by these valuable acquisitions, an added impulse was given to his pursuit. He quickly found the key to families and genera. He had never seen anything like it before, and then for the first time he recognized its use and its value. Here was order and system. "Going out into the garden," he says, "I broke off a branch of a native shrub the common name of which was familiar, and easily traced it to Viburnum Lentago. This threw me into a perfect fever of excitement. I rushed out for fresh material with which I was equally successful." The way was now clear, and he quickly became familiar with every tree, shrub and herb about him. He started a little herbarium on sheets of quarto size, preparing the specimens as nearly as possible like the plates in the books he was studying, and drawing on the sheets the flower and fruit analyses. He had no idea that a fruit of any size, such as that of Echinocystis, could be pressed. We must not, indeed, despise the day of little things. From this small beginning and as a direct consequence of it, sprang the splendid herbarium of later years.

In the meantime Mr. Bebb's father had become actively engaged in polities. In the presidential campaigns of 1840 and 1844, he figured prominently as a zealous Whig, and in 1846 he was nominated for governor of Ohio on the Whig ticket and elected by an overwhelming majority. Governor Bebb declined, however, a second nomination and decided to withdraw from public life. Purchasing a tract of land embracing five thousand acres in the Rock river valley, in Winnebago county, northern Illinois, one hundred miles northwest of Chicago, he moved his whole family thither in the spring of 1850. To this estate he gave the name of Fountaindale. The regular route was by canal packet on the Miami canal to Sandusky, and thence by steamer to Chicago. Michael, at this time a boy of seventeen years, full of youthful vigor and enthusiasm, took quite a different course. He assisted his brother-in-law in driving a herd of Short-horn cattle into the state of Illinois. Here was certainly a novel experience. The distance was four hundred miles, and a new flora was constantly opening out before him, giving him fresh delight each succeeding day.

The new home to which we are now introduced was to be the scene of important botanical labors. The boy botanist was to become a trained and skilled veteran, and his efforts were to be concentrated upon his favorite specialty. The estate consisted of beautiful, rolling, prairie land, "well watered," he says, "by cold, clear, spring-fed brooks, along the banks of which, where the water courses had given partial protection from prairie fires, were fine, open groves of oak." The house, built after a design by Charles Downing, was constructed of lumber hauled from Chicago, and was fifteen miles distant from the nearest town. The virgin prairie filled our young friend with eager delight. "Ah!" he writes, "that was lovely beyond description, and a perfect paradise for the out-of-doors botanist." His cup was full and running over with joy when he came into possession at this time of four standard books, Wood's Class Book of Botany, Gray's Botanical Text Book and Manual, Torrey and Gray's Flora of North America, and Gray's Genera Illustrata. Imagine the feelings of a young botanist, longing for the proper kind of systematic instruction, on receiving at one and the same moment such a collection as this. But it was still five or six years more before he was to know the advantage and the keen pleasure to be derived from personal acquaintance with fellow botanists, and the consequent interchange of ideas as well as exchange of specimens.

During the early years of the family life at Fountaindale, Michael, besides working on the farm and studying the native flora, attended Beloit college at Beloit, Wisconsin. About the year 1856 he met by chance, at one of the state fairs which he was attending, Dr. George Vasey, then living at Ringwood, Illinois. The acquaintance soon ripened into a warm friendship, and the reception of a package of grasses, sedges, and junci from Dr. Vasey a few weeks later, gave him the first taste of the delights of receiving authentically named botanical specimens from others. It is interesting to hear what he says of this event. Such enthusiasm belongs to the true botanist. "I cannot tell how rich this made me. I spread the specimens out over the floor, over the chairs, over the piano. I gloated over them. Here were some of the very things from 'Oneida Co., N. Y.,' mentioned in Dr. Torrey's Flora! What rare and valuable authentic material!"

In 1857 he was married to Katherine Hancock at Barre, Massachusetts, and it was shortly after this that the whole family moved away from Fountaindale, and for a few years Mr. and Mrs. Michael Bebb lived in various parts of the state, in Odin and Salem, southern Illinois, and in Springfield. At these places he made extensive collections of plants. In 1859 he made a trip east and derived fresh inspiration from meeting Dr. Asa Gray. At Springfield, Massachusetts, he attended a meeting of the American Association for the Advancement of Science, where he met the eminent botanists of the day, and he returned home with new and enlarged ideas as to what to do and how to do it. Nobody was more ready to profit by the advice and experience of others.

Meanwhile Mr. and Mrs. William Bebb after leaving Fountaindale went to Knoxville, Tennessee, where Mr. Bebb practised law and interested himself in a Welsh colony which was starting in the mountains of eastern Tennessee. At the outbreak of the civil war, however, the family lost everything, even their personal property, and were driven from the state. They went to Washington where, through the influence of President Lincoln, Mr. Bebb obtained a position in the Patent office. They moved to Rockford, Illinois, in 1869, where Mr. Bebb died in 1873, and his wife in 1892.

In the latter part of 1861 Michael Bebb moved to Washington with his wife and two children and obtained a position in the Pension office. Here he remained till 1867, and in spite of the duties of his office and the troublous times of the war, it was a period of intense botanical delight and activity with him. He quickly became acquainted with the leading scientific men of the city, joined the Naturalists' Club, collected plants eagerly during his hours of leisure, carried on a large correspondence with the botanical world and made copious exchanges. He soon became the intimate friend of Mr. William M. Canby, and his many letters to this well-known botanist are true botanical treasures. They show the real spirit of scientific enthusiasm and give a clue to that love of careful research that enabled him to become so accurate in his observations. He paid special attention to the difficult genus Juncus and illustrated his notes by careful drawings of details.

This material he afterwards handed over to Dr. George Engelmann for his revision of that genus. He numbered among his correspondents at this time, Asa Gray, Canby, Robbins, Vasey, Eaton, E. Hall, Porter, F. Peck, Mead, Blake, Clinton, Bolander, T. F. Allen, T. Green, Gmelin, and many others. The friendships that came to him through his scientific pursuits appealed to him very deeply. In 1862 he writes to Mr. Canby, "Botany is eminently a social science, and among the purest and best of the pleasures the pursuit thereof brings me, I count the friendship of fellow students." How true this was, those who knew him best can testify. He was a most "lovable man" and his intimate friends valued his friendship among their dearest possessions.

In 1865 his wife died, leaving him with three little children, two boys and a girl, and in June, 1866, he resigned his position at the Pension office. On February 19, 1867, Mr. Bebb married Anna E. Carpenter of Providence, Rhode Island, who became the mother of four sons and two daughters. She was a graduate of Mount Holyoke Seminary, in Massachusetts, and a daughter of Edmund and Lemira Carpenter whose parents were prominent during the Revolution. A few weeks after their marriage they left Washington and went to Illinois. Mr. Bebb's father, being at this time in Washington and not desiring to return to Fountaindale, had offered the estate for sale, and Mr. Bebb, who had always longed to realize the ideal life of a country gentleman, bought the old homestead with its acres of rich prairie land. Financially the undertaking was not a success, and in 1873 he thought seriously of selling the place, owing to the "large influx into the west of a foreign population and consequent overproduction of farm staples" which had destroyed farming except for those willing to work with their own hands for small returns. His pecuniary affairs, however, took a turn for the better soon after, and he decided to remain where he was. Still his life in Fountaindale was a checkered one. He was forced to contend against every discouragement for many years in the midst of his ardent pursuit of botany. During this time and afterwards, when his health began to fail, in all his labors on the farm and among his plants, in all his triumphs and in all his disappointments, he was ever sustained and encouraged by the constant devotion and ready self-sacrifice of his wife. She cheerfully and lovingly took upon herself almost the entire care of the household, brought up a family of nine children, and yet found time to take a deep interest in her husband's botanical work and be his constant aid. To her is largely due the success which he attained as an eminent salicologist.

It was about the year 1873 that Mr. Bebb gave himself up to the special study of willows. He had shown a growing interest in this subject for some years, and at this time was corresponding with Rev. J. E. Leefe, the British authority on Salix. Even as far back as February, 1861, he wrote "Salix is my pet genus if I have any special preference." No decided inclination, however, was shown in this direction till now. It is interesting to note the circumstance that led him to devote himself heart and soul to this group. He tells the story briefly in his own fascinating words. "Within gunshot of the house was a charming bit of lowland prairie upon which flourished the most diversified wild growth of willows I ever saw or heard of—my school in the study of this genus." This lay along a creek and was entirely undisturbed by cultivation. Mr. Bebb guarded it with jealous care, and in this school, with nature for a teacher, he learned how to unravel many a knotty problem. He soon became an authority, and in 1874 he was asked by Dr. Asa Gray to contribute the Salices to Brewer and Watson's Botany of California. It was in this year that he published in the *American Naturalist* his first paper on willows, entitled "A new species of willow (S. laevigata) from California, and notes on some other North American species."

In a letter to Dr. Gray, dated January 3, 1873, Mr. Bebb speaks of his longing for spring that he might set out his salicetum. This plantation of willows grew to large proportions and was of the greatest value to him in his studies. It covered an extent of two acres and was composed, Mrs. Bebb says, "of rare and varying forms of our native willows, which were sent to him by correspondents, and also a fine collection of European willows sent by Dr. Hooker from Kew." The labor and care expended in collecting, planting and tending this willow garden can hardly be overestimated. In May, 1873, he writes that of one thousand cuttings sent him from Kew all came up successfully.

It was in 1858 that he laid the foundation of his herbarium, and by 1873 it had assumed very large proportions. It consisted of about 15,000 species, illustrated by over 30,000 specimens. For fifteen years he had enjoyed a liberal exchange with the best collectors, and his special effort had been to illustrate the Gray Manual Flora, each species showing, as far as possible, flower, fruit and root, with marked varieties and geographical range. Besides these he had valuable additions from Europe and Southern Africa, and all these specimens he mounted himself with loving care. The specimens of his own collecting were of the finest quality, and were always an object of admiration to those who possessed them. He still carried on his wide botanical correspondence, and in 1878 he began to publish in the BOTANICAL GAZETTE various notes on willows, and this he continued to do till 1891. These consisted of six papers, entitled "Notes on North American willows," besides special observations on individual species. In this same year, 1878, he published the willows in Rothrock's Botany of the Wheeler Report, and in 1880 appeared his work on the willows in the Botany of California. In 1880 Nils J. Andersson, the eminent Swedish authority on the genus Salix, died, and Mr. Bebb stood without a rival at home or abroad. Every important collection of willows made in this country passed through his hands for determination, and not the least valuable portion of the work left behind him are these plants authentically named and scattered through the leading herbaria both here and in Europe.

Life in Fountaindale, however, at last came to an end, and in October, 1879, the family moved to Rockford, Ill. They still continued to visit the old home during the summer months, but, a few years later they sold the place, where Mr. Bebb had lived so long and had done so much valuable work on the willows, that the very words willow and Fountaindale will always be associated with each other. A practical farmer bought the estate, and truly did Mr. Bebb mourn the fate of his beloved garden. The wild growth of willows, his school in the study of that genus, "was speedily grubbed, drained and seeded down," he relates sadly. "The plantation of willows, which had cost me so much in care and outlay, was seized as a capital place to feed steers, and enclosed by a high board fence. The teams drove along between the rows. The fodder was thrown off on the bushes, and the cattle followed, eating at their leisure, with an occasional bite of bitter willow for tonic and stimulant." Even in times of deep distress he could show his fine sense of humor.

During the first few years of his life in Rockford, Mr. Bebb was as active as ever in his botanical pursuits, and in 1880 he attended the meeting of the American Association for the Advancement of Science at Portland, Maine. He had been present at the meeting of this society in 1872, at Dubuque, Iowa. In the winter of 1880 and 1881 he issued his first fascicle of Salices. These consisted mainly of specimens from plants either growing naturally at Fountaindale or set out in his willow plantation. Any herbarium is rich that possesses this collection. His skill as a draughtsman is shown in the beautiful drawings that accompany the plants. Mr. Bebb fully intended and hoped to issue a second fascicle, and he often referred to it in his letters, but various circumstances, combined with ill health, unfortunately prevented. In the autumn of 1885 he was seized with a severe attack of pleurisy and he never after regained perfect health. His interest in botanical subjects was still unabated, and he was enabled to accomplish much valuable work. He published in the *Bulletin* of the Torrey Botanical Club, between 1888 and 1890, four series of "Notes on the White Mountain willows," and in 1890 he contributed the Salices to the sixth edition of Gray's Manual. His correspondence from this time until his death is full of the charm of a graceful letter writer. He was always interested in all the questions of the day as well as in all branches of science. At one time he pursued with great zeal the study of conchology and made quite a collection of shells, and he acquired a good knowledge of entomology and geology, fully realizing the importance of their bearing on the study of plants.

Mr. Bebb was of a retiring nature, and most of his time in Rockford was spent in the privacy of his family. To his familiar correspondents his letters were always full of charming pictures of home scenes, and by many he will be affectionately remembered not as the botanist merely, but as a loving and devoted father. During a great deal of this time he was well enough to enjoy heartily the various festivities that the years brought round, and I cannot forbear giving his account of a Christmas scene in December, 1889. "From early morn when the youngsters came tumbling down stairs before it was yet light to explore the depths of their stockings, until late in the evening when the last member of the family put out the lights and went, rather tired withal, to bed, we had one of just the merriest, happiest Christmases imaginable. Not a ripple of discontent to mar the enjoyment of the family festivity. The children were hilarious and the old folk serenely content. The demon of misfit, who stalks abroad at this season, overcoming some good, kindly, well-intentioned souls, happily brought not a single one of our friends under his baleful spell. On the contrary, many a little gift was rendered thrice welcome, because it at once recalled some wish expressed months ago and forgotten, save as loving remembrance on the part of others carried it on to the joyous season of good-will to all."

Adjoining his house was a small garden, and this was always his great delight. He worked in it constantly and kept it well supplied with hardy shrubs and perennials, many of which he secured from the Arnold Arboretum. His herbarium which is estimated to contain about 50,000 specimens, besides the willows, was still his constant thought. Though during his life in Rockford he was unable to add much to his general collection, he kept up his Salix herbarium to the very last. His willows filled two walnut cabinets, about three by five feet in dimensions, and these he kept apart from his other plants, and close at hand for ready use.

He was a member of the Philadelphia, Buffalo, and Chicago Academies of Science, and was complimented by having several plants named in his honor. In 1885 Prof. E. L. Greene published in the *Bulletin* of the California Academy of Science the genus *Bebbia*, native to Southern California and Arizona, with the following inscription: "The genus is dedicated to Mr. Michael S. Bebb of Rockford, Ill., an able botanist to whom all students of the science on the Pacific coast are indebted for the careful elaboration of our species of the difficult genus *Salix* in the second volume of the Botany of California." In 1889 Prof. L. H. Bailey created the variety, *Carex tribuloides* Wahl. var. *Bebbii*, common to the Gray's Manual region, and in 1895, Prof. C. S. Sargent published, in *Garden and Forest*, *Salix Bebbiana*, a species of northern North America, inscribing it to Mr. Bebb, "the learned, industrious and distinguished salicologist of the United States to whom, more than to any one else of this generation we owe our knowledge of American willows."

Though naturally shrinking from public notice, Mr. Bebb did his share as a faithful citizen of Rockford. For eight years he was a member of the school board and he assisted largely by his energy and wisdom in raising the public schools to their present high standard. For eight years he served on the library board. In 1888 he bought a piece of land in southern Wisconsin on the shore of the Lauderdale lakes and built a small house, where for eight successive years the family spent their summers in rest and retirement. In this way Mr. Bebb avoided the summer heat and there he did some of his best work on the willows. He built with his own hands a lapstreak boat large enough to take all the family, and he was never tired of being rowed about over the clear water. August 9, 1888, he writes, "At the extreme west end of Middle lake are a number of immense springs probably the outlet of some subterranean communication with other bodies of water. They vary from ten to one hundred feet in depth, and to float over them in a boat gives one a strange impression, as if suspended in mid-air. The water is beautifully clear and slightly impregnated with sulphur. Down the sides of the bowl-shaped springs the banks are covered with an aquatic growth of fresh-water algæ of an intense emerald green, through which run sharply defined streaks of an intense purple or amethystine color, probably also a vegetable growth. At the bottom the water rises through clear white sand." Such descriptions as these show the delicately refined nature of the man.

Each year he found it harder to endure the rigorous winters of northern Illinois, and in January, 1893, he went alone to Demorest, Georgia, where he stayed between two and three months. His letters from this place are full of beautiful accounts of the scenery about him. He even felt able to do some salix work, for he contemplated a monograph of the North American willows, embodying the results of his many years of study. In January, 1894, he went to Clearwater Harbor, Florida. He enjoyed his stay there for three months and, before returning home, spent two weeks in Demorest. His last trip south was with his wife in January, 1895. They kept house for three months in Demorest, but unexpected cold weather rendered this visit unsuccessful, and Mr. Bebb was glad to get home.

In June, 1895, he published the willows of the Peary Auxiliary Expedition in *Bulletin V* of the Geographical Club of Philadelphia. With this exception he had not published anything since 1891. His last contributions to the subject were now soon to follow. He devoted himself to work with a good deal of energy in the summer of 1895 toward finishing some notes which he had promised to *Garden and Forest*, and near the close of the year he published in these columns five series of "Notes on some arborescent willows." Mr. Bebb assisted in the forth-coming volume of Sargent's Silva by selecting the material from which Mr. Charles E. Faxon drew the willow plates, and by criticising the sketches which were all submitted to him.

During the past year, however, consumption had set in and his strength was failing fast. His summer at Lauderdale had brought no improvement, and it was decided to pass the winter in San Bernardino, California. He started with Mrs. Bebb November 2d, full of courage and hope, and he even formed plans of going on with the task which he had at heart. He was not able, however, to touch any botanical work, but constantly grew weaker. Mr. and Mrs. Samuel B. Parish were unremitting in their kind attentions and helped to brighten the last moments of the sick man. At last on the morning of December 5, 1895, Mr. Bebb passed quietly away surrounded by his wife and loving friends. The funeral took place at the family home at Rockford on December 13th. Dr. Thomas Kerr, his pastor, conducted the ceremony and spoke beautifully of Mr. Bebb's life and work. His six sons bore him from the house, and he was laid to rest in the West Side cemetery in the city.

Though Mr. Bebb was not allowed to finish his long cherished work, the revision of the willows for the Flora of North America, still he has left invaluable material relating to the subject, besides his salix herbarium containing the collections of years and enriched by his own notes and drawings. All this will be the basis of future work. Mr. Bebb by his character and ability honored the science with which he was so long identified, and he will always be remembered as a botanist of the highest rank.

Cambridge, Mass.

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Notes on our Hepaticæ. IV.

The genus Fossombronia.

LUCIEN M. UNDERWOOD.

Among the genera of the Jungermaniales the present genus is perhaps the only one in which the spore markings have been used as specific characters. The older hepaticologists failing to recognize these important characters failed in many instances to discriminate the species and in many of the earlier exsiccatæ the same name covers two or three species which are now clearly recognized by spore characters. Our own species have been indiscriminately referred to common European species and as this was done before the right recognition of species obtained there, we have a complicated tangle of misapplied names to unravel.

In order of sequence the following species have been referred to our flora by various authors.

1821. Schweinitz described[1] *Anthoceros jungermannioides* which is evidently a species of *Fossombronia* as first pointed out by Sullivant in 1845. While it probably represented *F. foveolata*, our most common species, there is no means at hand of verifying the supposition.

1845. Sullivant distributed[2] *Fossombronia pusilla*, from Mobile, Ala. As his specimens, at least in my set of the Musci Alleghanienses, are sterile, it is not possible to determine with certainty what species this is, the foliar characters not being sufficiently distinct to discriminate species properly.

1856. Sullivant again reported[3] *F. pusilla* from "moist places on the ground; mostly southern." His figure (the same that now appears in the sixth edition of Gray's Manual) does not even approximately represent the spores of any of our species. It is reasonably certain, however, that the species he has figured is really *F. foveolata*.

1869. Austin published[4] *F. cristula* from New Jersey and

[1] Spec. Fl. Am. Sept. 25. 1821.
[2] Musc. Alleg. *no.* 277. 1845.
[3] Mosses and Hepaticæ of the Eastern U. S. in Gray, Man. 691. 1856. (ed. 2.)
[4] Proc. Phila. Acad. 1869; 228. 1869.

Androcryphia longiseta from California and Texas, giving *F. longiseta* Aust. MS. as a synonym for the latter.

1872. Austin issued four species[5] as follows: *F. longiseta* no. 118, *F. angulosa*, no. 119, *F. pusilla*, no. 120, and *F. cristula*, no. 121.

1875. Lindberg in commenting on Austin's exsiccatæ[6] recognizes nos. 118 and 121 as good species, the former allied to *F. cristata* and the latter to *F. foveolata* of Europe. With no. 118, he says, a second species occurs (the Texas specimens) which he briefly characterizes under a name (*F. Texana* Lindb. MS.). No. 119 he asserts is not *F. angulosa* as known in Europe, and he briefly characterizes the sterile specimens under the MS. name of *F. salina* Lindb. No. 120 he refers doubtfully to *F. foveolata* but later[7] refers it to this species with more positiveness.

1876. Austin described[8] *F. Macouni* from Canada (Portage La Lochs, lat. 57°), and *F. Wrightii* from Cuba (the latter based on material distributed later in Hep. Cubenses Wrightianæ as "*F. pusilla*"), and briefly characterized the Texan specimens (originally included in *F. longiseta* and named *F. Texana* by Lindberg) under the name of *F. Cubana* (Gott.) Aust., including with them material collected in Cuba by Charles Wright which had been named by Gottsche and were afterwards distributed in Hep. Cubenses Wrightianæ as "*F. pusilla*, var. *Cubana* G."

The above species represent all the material that was known to me when the compilation was made for my descriptive catalogue of species.[9] It is fair to state that at the time of publication of that paper Lindberg's publication noted above was not known to me.

1889. Underwood and Cook issued[10] specimens of *F. Dumortieri*[11] as no. 47. This species had previously been cited

[5] Hepaticæ Boreali-Americanæ.

[6] Hepaticæ in Hiberniæ lectæ. Acta Soc. Scien. Fenn. **10:** 533. 1875.

[7] Rev. Bryol. **12:** 39. 1885.

[8] Bot. Bulletin (now Bot. Gazette) **1:** 36. 1876.

[9] Bull. Ill. State Lab. Nat. Hist. 2: 1–133. 1884.

[10] Hepaticæ Americanæ, dec. V-VI. N 1889.

[11] The name of this species here given cannot stand under the present rules of nomenclature as it was based on a *nomen nudum* and that issued in exsiccatæ. Lindberg's original name, therefore, must hold. The synonymy of the species is as follows:

FOSSOMBRONIA FOVEOLATA Lindb. 1873.

Codonia Dumortieri Hueb. et Genth. Deutschlands Lebermoose in getrockneten Exemplaren *no. 80.* 1837; name only.

Fossombronia Dumortieri Lindb. Not. pro F. et Fl. Fenn. **13:** 417. 1874.

as American by Lindberg (Drummond, Musc. Amer. II. no. 163 from Louisiana).

1892. Underwood reported[12] *F. cristata* from Indiana.

From a study of the herbarium material at hand we appear to have the following species:

1. F. ANGULOSA (Dicks.) Raddi. Mem. della Soc. Ital. di Mod. **18:** 40. 1818.

Cuba, *Wright;* Florida, *Underwood;* Alabama, *Underwood;* Texas, *Thurow.* The specimens issued in Hep. Amer. no. 118 differ from representative European specimens in shorter elaters and slightly larger spores, in both particulars varying in the direction of *F. foveolata.* They are apparently dioicous.

2. F. CRISTATA Lindb. "apud Soc. pro F. et Fl. fenn. die 6th Dec. 1873" Not. pro F. et Fl. fenn. **13:** 388. 1874.[13]

Indiana, *Underwood;* Ohio, *Werner.*

3. F. CRISTULA Aust. Proc. Phila. Acad. **1869:** 228. 1869. New Jersey, *Austin;* Distributed in Hep. Bor.-Am. *no. 121.*

4. F. FOVEOLATA Lindb. "apud Soc. pro F. et Fl. fenn. die 6 Dec. 1873." Not. pro F. et Fl. fenn. **13:** 382. 1874.[13]

Maine, *Rand;* New Jersey, *Austin;* Delaware, *Commons, James;* Ontario, *Macoun, Britton;* British Columbia, *Macoun.* Sterile specimens from South Carolina, *Ravenel,* seem also to belong here as is also the case with various similar specimens in exsiccatæ.[14] Distributed in Hep. Amer. as *F. Dumortieri, no. 47.*

5. F. LONGISETA Aust. *as syn.* Proc. Phila. Acad. **1869:** 228. 1869.

Androcryphia longiseta Aust. l. c.

California, *Bolander, Brandegee, Farlow, Parish, Howe.* Distributed in Hep. Bor.-Am. *no. 118,* and in Hep. Amer. *no. 157.*

6. F. TEXANA Lindb. Acta Soc. Scien. fenn. **10:** 533. 1875.

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[12] Proc. Ind. Acad. Science **1891:** 90. 1892.

[13] I have been unable to verify the earlier citations of Lindberg. The species are described in the second paper cited, with illustrations of the spores.

[14] E. g., Musc. Alleg. *no. 277.* Hep. Bor.-Am. *no. 120.* Canadian Hepat. *no. 64.*

F. Cubana (Gott.) Aust. Bot. Bulletin (now Bot. Gazette) **1**: 36. 1876.

F. pusilla, var. *Cubana* Gott., name only, in Hep. Cubenses Wrightianæ.

Cuba, *Wright;* Austin also reported it from Texas but I have no means of verifying the reference.

7. F. WRIGHTII Aust. Bot. Bulletin (now Bot. Gazette) **1**: 36. 1876.

Cuba, *Wright.*

SPECIES DUBIÆ.

8. F. PUSILLA (L.) Dumort. Recueil d'obs. sur les Jung. 11. 1835.[15]

This species so often alluded to in the above references must be placed in the doubtful list as we are unable to cite a single fertile plant from any part of North America.

9. F. SALINA Lindb. Acta Soc. Scien. fenn. **10**: 533. 1875.

F. angulosa Aust. Hep. Bor.-Am. *no. 119*, not Raddi.

This species founded on sterile specimens will have to be placed in the doubtful list unless fertile specimens can be found. It is unfortunate that it was ever given a name!

10. F. MACOUNI Aust. Bot. Bulletin (now Bot. Gazette) **1**:36. 1876.

"Portage La Lochs, lat. 57°, Macoun." I have seen no specimens of this species. Mr. Pearson writes me that no specimens exist in either of the parts of the Austin collection; nor does Mr. Macoun, its collector, possess any specimens.

In order to facilitate the determination of our species I append the following table with the more important characters emphasized.

**Spores clearly foveolate or reticulate.*

Elaters few or wanting; spores pale brown, 35–44μ; paroicous . . . . *F. cristula.*

Elaters abundant; spores dark brown.

Dioicous; spores 35–40 with few reticulations; elaters 220–250μ . . . . *F. angulosa.*

Heteroicous; spores 42–50μ with more numerous reticulations; elaters 120–135μ . . *F. foveolata.*

[15] Dumortier clearly intended to write "pusilla" at this reference, but by a singular typographical error he wrote "pumila" which happens to be also one of the species of the Linnaean genus Jungermania.

***Spores spinulose-cristate, the crests only occasionally anastomosing.*

Dioicous.

Spores 29–40μ; elaters 160–300μ . . *F. longiseta.*

Spores 50–60μ; elaters 135–200μ . . *F. Texana.*

Heteroicous; spores 29–40μ; elaters about 120μ. *F. cristata.*

****Spores verrucose*, 53–56μ; dioicous? . . *F. Wrightii.*

Having never seen *F. Macouni* I can only quote Austin's description of its spores: "*Sporis parviusculis subopacis densissime minutissime papillosis.*" It would doubtless fall in the table near *F. Wrightii.*

It is hoped that collectors will send in material illustrating more fully the distribution of this interesting genus. The species all grow in sandy or clayey soil, closely creeping, and for the most part produce their spores late in the season. I desire also that those who possess either Austin's Hep. Bor. Am. or Sullivant's Musc. Alleg. examine the species above noted for spores and report any modifications necessary in the statements. The spores of the European species have been figured in accessible works, *e. g.* Not. pro Fl. et Faun. Fenn **13:** *pl. 1.* and Rev. Bryol. **17:** *pl. 1.* These include *Ff. angulosa, foveolata, cristata,* and *pusilla* besides other species not found in America.

Auburn, Ala.

Flowers and insects. XV.[1]

CHARLES ROBERTSON.

POLYGONUM Tourn.—For the present I withhold the consideration of the mode of pollination and of the copious special literature and contribute lists of insect visitors of the two following species.

POLYGONUM PENNSYLVANICUM L.—The visitors observed on nine days between Aug. 8th and Sept. 16th, are as follows:

HYMENOPTERA—*Apidæ:* (1) Apis mellifica L. ☿, ab.; (2) Bombus separatus Cr. ♂; (3) B. americanorum F. ♂☿; (4) B. virginicus Oliv. ♂☿, ab.; (5) Megachile brevis Say ♂; *Andrenidæ:* (6) Andrena asteris Rob. ♂; (7) Agapostemon radiatus Say ♂; (8) Augochlora viridula Sm. ♀; (9) A. pura Say ♀; (10) Halictus fasciatus Nyl. ♀; (11) H. pilosus Sm. ♀; (12) H. confusus Sm. ♀; (13) H. stultus Cr. ♀; *Vespidæ:* (14) Polistes pallipes Lep.; (15) P. rubiginosus Lep.; (16) P. metricus Say; (17) P. annularis L.; *Eumenidæ:* (18) Odynerus tigris Sauss., freq.; (19) O. capra Sauss., freq.; *Crabronidæ:* (20) Crabro interruptus Lep.; (21) C. 6-maculatus Say; *Philanthidæ:* (22) Cerceris clypeata Dlb.; *Larridæ:* (23) Ancistromma distincta Sm.; *Sphecidæ:* (24) Ammophila intercepta Lep.; (25) Chlorion caeruleum Dru.; (26) Priononyx atrata Lep.; *Pompilidæ:* (27) Pompilus philadelphicus Lep.; (28) Priocnemis fulvicornis Cr.; (29) Planiceps niger Cr.; *Scoliidæ:* (30) Myzine sexcincta F.—all sucking.

DIPTERA—*Bombylidæ:* (31) Sparnopolius fulvus Wd.; *Syrphidæ:* (32) Syrphus ribesii L.; (33) S. americanus Wd., freq.; (34) Mesograpta polita Say; (35) M. marginata Say; (36) Eristalis tenax L.; (37) E. aeneus F.; (38) Tropidia quadrata Say; (39) Syritta pipiens L.; *Tachinidæ:* (40) Cistogaster immaculata Mcq.; (41) Jurinia smaragdina Mcq., ab.; (42) J. apicifera Wlk.; (43) Micropalpus fulgens Mg.; (44) Frontina acroglossoides Twns.; (45) F. flavicauda Riley; (46) Atrophopoda singularis Twns.; *Sarcophagidæ:* (47, 48) Sarcophaga spp.; *Muscidæ:* (49) Graphomyia sp., freq.; (50) Lucilia caesar L.; (51) L. cornicina F.; (52) Compsomyia macellaria F.—all sucking.

LEPIDOPTERA—*Rhopalocera:* (53) Pieris protodice B.-L.; (54) P. rapæ L.; (55) Colias philodice Gdt.; (56) Chrysophanus thoe B.-L.; (57) Pamphila cernes B.-L.; *Heterocera:* (58) Heliothis armiger Hüb.; (59) Scepsis fulvicollis Hüb.—all sucking.

COLEOPTERA—*Lampyridæ:* (60) Chauliognathus pennsylvanicus DeG., s., ab.

POLYGONUM HYDROPIPEROIDES Michx.—The following visitors were observed Aug. 30th and Sept. 20th:

[1] Contributions to an account of the ecological relations of the entomophilous flora and the anthophilous insect fauna of the neighborhood of Carlinville, Illinois.

HYMENOPTERA—*Apidæ:* (1) Apis mellifica L., ☿; (2) Ceratina dupla Say ♀; (3) Megachile brevis Say ♂; (4) M. mendica Cr. ♀; *Andrenidæ:* (5) Andrena solidaginis Rob. ♀; (6) Agapostemon radiatus Say ♂ ♀; (7) Halictus coriaceus Sm. ♂, freq.; (8) H. lerouxii Lep. ♀; (9) H. fasciatus Nyl. ♀; (10) Colletes armata Pttn. ♂; (11) C. eulophi Rob. ♂; (12) C. americana Cr. ♂ ♀, freq.; (13) C. latitarsis Rob. ♀; (14) Prosopis pygmaea Cr. ♂; *Vespidæ:* (15) Polistes pallipes Lep.; (16) P. metricus Say; *Eumenidæ:* (17) Odynerus capra Sauss.; (18) O. dorsalis F.; (19) O. arvensis Sauss.; *Crabronidæ:* (20) Crabro texanus Cr.; (21) C. trifasciatus Say; (22) Thyreopus tumidus Pack.; (23) Anacrabro ocellatus Pack.; (24) Oxybelus 4-notatus Say; (25) O. emarginatus Say; *Philanthidæ:* (26) Philanthus ventilabris F.; (27) P. punctatus Say; (28) Eucerceris zonatus Say: (29) Cerceris fumipennis Say; (30) C. kennicottii Cr.; *Nyssonidæ:* (31) Gorytes phaleratus Say; *Larridæ:* (32) Astata bicolor Say; (33) Ancistromma distincta Sm.; (34) Tachytes aurulentus F.; *Sphecidæ:* (35) Pelopoeus cementarius Dru.; (36) Isodontia philadelphica Lep.; (37) Sphex ichneumonea L.; (38) Priononyx thomæ F.; (39) P. atrata Lep.; *Pompilidæ:* (40) Pompilus philadelphicus Lep.; (41) P. algidus Sm.; (42) P. biguttatus F.; (43) P. navus Cr.; (44) Ceropales fraterna Sm.; *Scoliidæ:* (45) Tiphia tarda Say; (46) Myzine sexcincta F.; *Mutillidæ:* (47) Sphaerophthalma macra Cr.; *Chrysididæ:* (48) Holopyga ventralis Say; (49) Hedychrum wiltii Cr.; (50) H. violaceum Brullé; (51) Chrysis texana Grib.; (52) C. nitidula F.

DIPTERA—*Bombylidæ:* (53) Systoechus vulgaris Lw.; *Conopidæ:* (54) Conops brachyrrhynchus Mcq.; *Syrphidæ:* (55) Paragus tibialis Fll.; (56) Eristalis bastardi Mcq.; (57) E. flavipes Wlk.; (58) Tropidia quadrata Say; (59) Syritta pipiens L.; *Tachinidæ:* (60) Jurinia apicifera Wlk.: (61) Frontina acroglossoides Twns.; *Sarcophagidæ:* (62–64) Sarcophaga spp.; *Muscidæ:* (65) Lucilia caesar L.; (66) L. cornicina F.; (67) Compsomyia macellaria F.; *Anthomyidæ:* (68) Coenosia sp.

COLEOPTERA—*Coccinellidæ:* (69) Coccinella 9-notata Hbst.; *Lampyridæ:* (70) Chauliognathus pennsylvanicus DeG.; *Chrysomelidæ:* (71) Disonycha limbicollis Lec. v. pallipes Cr.; *Curculionidæ:* (72) Listronotus caudatus Say.

DIRCA PALUSTRIS L.—This is a low shrub blooming quite early, March 18th to April 13th, and bearing small greenish yellow flowers which appear before the leaves. At the ends of the branchlets are situated buds of about four hairy scales enclosing, in cases observed by me, three flower-buds and a leaf-bud. The flowers are pendulous and are sheltered by the bud scales which form a hood above them.

The calyx tube is about 5^{mm} long and is truncate, with obscure lobes. The bottom of the tube is completely filled by the ovary so that with a proboscis 4^{mm} long a bee may obtain all the nectar, which I think is secreted by the tube. For the distance of about 1^{mm} from the ovary to the point where the stamens are inserted the tube is narrow. Above that point it is wider but is obstructed by the eight filaments and the style. The anthers are exserted about 2^{mm} beyond the mouth of the tube, the alternate ones being somewhat shorter. The stigma is advanced about 2^{mm} further.

In a bud which had just begun to open I found that the flowers had the anthers reaching just to the mouth, but the stigmas advanced 2^{mm} beyond. The anthers were closed but the stigmas were receptive. There was thus an appearance of proterogyny, but it must be short-lived, for all of the other flowers which I observed had the anthers dehiscent, the larger ones, however, shedding their pollen first. The arrangement for cross-pollination is the simple one, common in pendulous flowers, of the stigma being in advance of the anthers. Pollination between flowers of the same plant may occur, but I think there is little chance of self-pollination.

As noted above, the calyx has obscure lobes, and my examination of early cases, in which the open mouths of the tubes were crowded with the swollen anthers, leads me to believe that the abortion of the lobes is correlated with the fact that the young flowers are protected by the scales which form the common envelope of the leaf-bud and the flower cluster.

The pendulous position of the flowers, the comparatively deep, narrow tube, and the early blooming time convince me that the flowers are adapted to the smaller bees. The following list of visitors, observed March 21st, confirms this view:

HYMENOPTERA—*Apidæ:* (1) Ceratina dupla Say ♂; (2) C. tejonensis Cr. ♂: (3) Osmia lignaria Say ♂; (4) Nomada maculata Cr. ♂; *Andrenidæ:* (5) Halictus sp. ♀; (6) H. zephyrus Sm. ♀; (7) H. confusus Sm. ♀; (8) Augochlora labrosa Say ♀; (9) Andrena rugosa Rob. ♂; (10) Colletes inaequalis Say ♂—all s.

LEPIDOPTERA—*Nymphalidæ:* (11) Vanessa antiopa L., s.

EUPHORBIA L.—As in the case of *Polygonum,* I omit remarks upon the mode of pollination and references to the literature.

EUPHORBIA COROLLATA L.—The stems grow from 6 to 10^{dm} high and are terminated by large umbel-like clusters with white involucres which make it the most conspicuous of our Euphorbias.

It was observed in bloom from May 24th to Sept. 27th. The following list, consisting mainly of flies, on which the plant seems to depend, with the exception of no. 1, was observed on July 25th:

DIPTERA—*Bombylidæ:* (1) Anthrax alternata Say; *Syrhpidæ:* (2) Paragus tibialis Fll.; (3) P. bicolor F.; (4) Pipiza pulchella Will.; (5) Chrysogaster nitida Wd.; (6) Allograpta obliqua Say; (7) Spaerophoria cylindrica Say; (8) Syritta pipiens L.; *Tachinidæ:* (9) Cistogaster immaculata Mcq.; (10) Miltogramma argentifrons Twns.; *Muscidæ:* (11) Lucilia cornicina F.; (12) Cyrtoneura sp.

HYMENOPTERA—*Andrenidæ:* (13) Prosopsis pygmaea Cr. ♀; *Pompilidæ:* (14)Pompilus relativus Fox.—all sucking.

HEMIPTERA—*Coreidæ:* (15) Chariesterus antennator F., s.

SALIX Tourn.—The flowers of willows are dioecious and entomophilous, but Warming (21) regards *S. herbacea* and some other species as anemophilous in Greenland. In the Alps, according to Müller (15), *S. herbacea* secretes abundant nectar and is visited by insects. Kerner (24) observed some species to be proterogynous, with the result that at first they could only receive pollen from flowers of other species and consequently produced hybrids.

Sprengel (1) regarded the staminate catkins as being more conspicuous than the pistillate in order that the latter might thus be more likely to be visited by insects which had first become dusted with pollen from the staminate flowers. While it is a fact that the staminate catkins are more attractive to insects, and, in spite of Bonnier's (11) statements to the contrary, are more abundantly visited by them, it can hardly be maintained that the increased conspicuousness was developed on this account, for, as claimed by MacLeod (27), the staminate flowers of anemophilous plants are also more conspicuous than the others. I have often noticed that the catkins of *Populus monilifera* were quite red or yellow, making them more brightly colored than in any of our species of *Salix*.

From their readily accessible nectar and exposed pollen, the catkins are especially attractive to the less specialized bees (*Andrenidæ*) and to the flower flies (*Syrphidæ*) and in most of the cases given in the table these are the most abundant guests, together forming a majority of all the visitors. Except for the services of these insects there seems to be little reason why the flowers should bloom early, for all of the other insect groups, except the *Empidæ*, have more species later in the season. I suspect that, whenever a satisfactory list of visitors of a willow is made out, it will show a preponderance of *Andrenidæ* and *Syrphidæ*, unless there is some peculiarity in the insect fauna of the region.

The following table gives the results of observations made in different regions in cases in which the insects have been identified:

Salix.	Region.	Observer.	Andrenidæ and Syrphidæ.	Other insects.	Other Hymenoptera.	Apidæ.	Andrenidæ.	Syrphidæ.	Other Diptera.	Other insects.
cordata	Illinois		49	38	7	8	28	21	18	5
humilis	Illinois		27	24	5	3	20	7	9	7
cinerea, caprea, aurita	Germany	Müller (6, 12, 17)	61	52	9	19	44	17	16	8
cinerea	Germany	Loew (20)	1	1	....	1	1	..	....	....
caprea	Germany	Loew (28)	11	5	....	4	11	..	1	....
aurita	Germany	Loew (20, 28)	1	2	....	1	..	1	1	....
nigricans	Germany	Loew (20)	1	1	....	1	1	..	....	....
alba	Germany	Loew (28)	....	1	....	..	..	..	1	....
amygdalina	Germany	Loew (28)	1	....	....	..	1	..	....	....
amygdalina	Germany	Müller (12)	2	3	....	1	2	..	2	....
fragilis	Germany	Müller (12)	2	4	1	1	2	..	....	1
repens	Germany	Müller (6, 17)	4	6	1	2	4	..	2	1
repens	Norderney	Verhoeff (26)	7	26	2	4	1	6	14	6
Early spp	Flanders	Mac Leod (27)	15	28	5	6	12	3	15	1
Late spp	Flanders	Mac Leod (27)	7	5	....	1	3	4	4	....
herbacea	Alps	Müller (15, 17)	....	2	....	..	..	..	1	1
reticulata	Alps	Müller (15)	....	1	...	..	..	..	....	1
retusa	Alps	Müller (15)	....	1	1	..	..	..	....	....

Those species which bloom before the leaves appear—as in the two following cases—are more abundantly visited because they have fewer competitors, and because their flowers are less concealed by the leaves.

SALIX CORDATA Muhl. blooms from March 18th to April 23d. On April 9–11th, 14th, 17th, 18th, and 20th the following insects were taken on the flowers:

HYMENOPTERA—*Apidæ:* (1) Ceratina dupla Say ♂, s., freq.; (2) Osmia lignaria Say ♂, s.; (3) Nomada sayi Rob. ♂♀, s., very ab.; (4) N. maculata Cr. ♂♀, s.,very ab.; (5) N. luteola Lep. ,♂♀ s., ab.; (6) N. luteoloides Rob. ♂, s.; (7) N. articulata Sm. ♂, s.; (8) N. integra Rob. ♂♀, s., ab.; *Andrenidæ:* (9) Andrena erythrogaster Ashm. ♂♀, s., and c. p., ab., in cop.; (10) A. sayi Rob. ♂♀, s., ab.. in cop.; (11) A. salicis Rob. ♂♀, s. and c. p.; (12) A. illinoensis Rob. ♂♀, s. and c. p., ab., in cop.; (13) A. flavo-clypeata Sm. ♂♀, s., ab., in cop.; (14) A. cressonii Rob. ♂, s., ab.; (15) A. nuda Rob. ♀, s.; (16) A. rugosa Rob. ♂♀, s.; (17) A. erythronii Rob. ♂, s.; (18) A. forbesii Rob. ♀, s.; (19) A. hippotes Rob. ♂, s.; (20) A. mariæ Rob. ♂♀, s. and c. p., ab.: in cop.; (21) A. claytoniæ Rob. ♂♀, s., ab.; (22) A. mandibularis Rob. ♂, s.; (23) A. pruni Rob. ♂; (24) Panurgus? andrenoides

Cr. ♂♀, s., very ab., in cop.; (25) Agapostemon radiatus Say ♀, s.; (26) Augochlora similis Rob. ♀, s.; (27) A. pura Say ♀, s.; (28) Halictus foxii Rob. ♀, s., ab.: (29) H. forbesii Rob. ♀, s., (30) H. lerouxii Lep. ♀, s., freq.; (31) H. pilosus Sm. ♀, s., freq.; (32) H. zephryus Sm. ♀, s.; (33) H. confusus Sm. ♀, s.; (34) H. stultus Cr. ♀, s.; (35) Sphecodes arvensis Pttn. ♀, s.; (36) Colletes inaequalis Say ♂, s.; *Vespidæ:* (37) Polistes rubiginosus Lep., s.; *Pompilidæ:* (38) Priocnemis conicus Say, s.; *Ichneumonidæ:* (39) Pimpla sp.; *Tenthredinidæ:* (40) Nematus vertebratus Say; (41) N. luteotergum Nort.; (42) Dolerus arvensis Say, s., ab ; (43) D. bicolor Bv., s., freq.

Diptera—*Simulidæ:* (44) Simulium sp. s.; *Empidæ:* (45) Empis otiosa Coq., s.; (46) Rhamphomyia gilvipilosa Coq., s.; *Conopidæ:* (47) Myopa vesiculosa Say, s.; (48) M. pilosa Will.; *Syrphidæ:* (49) Psilota buccata Mcq.; (50) Chrysogaster pictipennis Will., ab.; (51) Chilosia sp.; (52) Melanostoma obscurum Say; (53) Platychirus hyperboreus Staeg.; (54) P. quadratus Say, freq.; (55) Syrphus ribesii L.; (56) S. americanus Wd., ab.; (57) Sphaerophoria cylindrica Say; (58) Chalcomyia aerea Lw.; (59) Brachyopa vacua O. S.; (60) Eristalis aeneus F., ab.; (61) E. dimidiatus Wd., ab.; (62) E. transversus Wd.; (63) E. flavipes Wlk.; (64) Helophilus similis Mcq., ab.; (65) Tropidia mamillata Lw.; (66) Brachypalpus rileyi Will., ab.; (67) B. frontosus Lw., very ab.; (68) Xylota fraudulosa Lw., ab.; (69) Syritta pipiens L.; *Tachinidæ:* (70) Gonia frontosa Say, ab.; (71) G. exul Will.; *Sarcophagidæ:* (72) Cynomyia sp., ab.; *Muscidæ:* (73) Lucilia cornicina F., ab.; *Anthomyidæ:* (74) Chortophila sp.; *Cordyluridæ:* (75) Scatophaga squalida Mg., ab.; *Sciomyzidæ:* (76) Tetanocera sp.; (77) T. pictipes Lw.; *Lonchaeidæ:* (78) Lonchaea sp.; (79) L. polita Say; *Sepsidæ:* (80) Sepsis sp.; *Oscinidæ:* (81) Oscinis sp.; *M. acalyptratæ:* (82) sp.—all s. or f. p.

Coleoptera—*Chrysomelidæ:* (83) Orsodachna atra Ahr., ab.; (84) Lina lapponica L., ab.; (85) Galeruca tuberculata Say, freq.; *Oedemeridæ:* (86) Asclera puncticollis Say, freq.—all s. or f. p.

Hemiptera—*Capsidæ:* (87) Lygus pratensis L. s.

Salix humilis Marsh.—This species was observed in bloom from the 18th of March to the 21st of April. On March 18th and April 6–12th, 14th, 17th, 20th and 21st the following visitors were noted:

Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Bombus virginicus Oliv. ♀; (3) Ceratina dupla Say ♂, freq.; *Andrenidæ:* (4) Andrena vicina Sm. ♂♀, ab.; (5) A. erythrogaster Ashm ♂; (6) A. salicis Rob. ♂♀, s., freq.; (7) A. illinoensis Rob. ♂; (8) A. erythronii Rob. ♂♀; (9) A. cressonii Rob. ♂; (10) A. flavo-clypeata Sm. ♂; (11) A. rugosa Rob. ♂; (12) A. forbesii Rob. ♀; (13) Agapostemon radiatus Say ♀; (14) Augochlora pura Say ♀; (15) Halictus arcuatus Rob. ♀; (16) H. forbesii Rob. ♀; (17) H. coriaceus Sm. ♀; (18) H. lerouxii Lep. ♀, ab.; (19) H. fasciatus Nyl. ♀; (20) H. confusus Sm. ♀; (21) H. pruinosus Rob. ♀; (22) Sphecodes arvensis Pttn. ♀; (23) Colletes inaequalis Say ♂♀, ab.; *Ichneumonidæ:* (24) Ichneumon funestus Cr.; (25) Colpognathus helvus Cr.: *Tenthredinidæ:* (26) Dolerus arvensis Say, ab.; (27) D. bicolor Br., ab.; (28) D. sericeus Say—all s.

Diptera—*Syrphidæ:* (29) Syrphus americanus Wd.; (30) Sphaerophoria cylindrica Say; (31) Eristalis aeneus F.; (32) E. dimidiatus Wd., ab.; (33) E. latifrons Lw.; (34) Helophilus similis Mcq., ab.; (35) Brachypalpus frontosus Lw., ab., *Tachinidæ:* (36) Gonia frontosa Say, ab.; *Sarcophagidæ:* (37) Cynomyia sp., ab.; *Muscidæ:* (38) Lucilia caesar L.; (39) Lucilia cornicina F., ab.; *Anthomyidæ:* (40-41) Chortophila spp.; (42) Hyetodosia 4-notata Mg.; *Cordyluridæ:* (43) Scatophaga squalida Mg., ab.; *Sepsidæ:* (44) Sepsis sp., ab.—all s.

COLEOPTERA—*Coccinellidæ:* (45) Hippodamia parenthesis Say; *Lampyridæ:* (46) Ellychnia corrusca L.; *Chyrsomelidæ:* (47) Orsodachna atra Ahr., ab.—all s.

HEMIPTERA—*Lygaeidæ:* (48) Lygaeus turcicus F.; *Pentatomidæ:* (49) Euschistus variolaris P. B. (det. by Uhler); *Capsidæ:* (50) Lygus pratensis L.—all s.

LEPIDOPTERA—*Rhopalocera:* (51) Vanessa antiopa L., s.

The staminate flowers are so thoroughly monopolized by hive-bees that other insects are almost entirely absent. Accordingly, most of the insects in the list were taken on the pistillate flowers which they visited only for nectar.

On the literature of *Salix* see:

(1) Sprengel, Das entdeckte Geheimniss 31. 437–8. 1793. *S. caprea* visitors, etc.—(2) Hildebrand, Geschlechter-vertheilung bei den Pflanzen 9. 12. 1867. Diclinism.—(3) Axell, Om anordningarna för de fanerogama växternas befruktning 47, 62, 93, 113. 1869. *S. pentandra, cinerea, nigricans.*—(4) White, Winter fertilization by agency of insects. Journ. Bot. N. S. **1**: 48, F 1872. Visitors of ♂ and ♀ fls.—(5) Delpino, Ulteriori osservazioni Pt. II. fasc. 2: (154). 1875. Atti d. Soc. Ital. d. Sci. Nat. in Milano. **16**: 302. 1873. Lit. (1) and (4).—(6) Müller, Befruchtung der Blumen 149–50. 1873.—(7) Kerner, Die Schutzmittel des Pollens 50. 1873.—(8) Kerner, Die Schutzmittel der Blüthen gegen unberufene Gäste. 1876. *S. daphnoides*, Wachsüberzüge. (Just Bot. Jahresbericht **4**: 942).—(9) Meehan, On self-fertilization and cross-fertilization of flowers. Penn Monthly. N 1876. *S. caprea.* Sep. pamphlet 1877. (Just **4**: 939).—(10) H. H., Fertilization of Salix repens. Nature **16**: 184. 1877. Visitors. (Just **5**: 746). — (11) Bonnier, Les Nectaires. Ann. d. Sci. Nat. Bot. **8**: 39, 49–50, 57, 70–1. 1879. Several spp., visitors, etc. — (12) Müller, Weitere Beobachtungen. II. Verh. d. naturhist. Ver. d. preuss. Rheinl. u. Westf. **1879**: 210.—(13) Behrens, Biologische Fragmente. Jahresbericht d. Naturw. Gesellschaft zu Elberfeld. 1880. *S. repens.*—(14) Delpino, Proporzione delle piante anemofile ed entomofile nelle isole. Revista Botanica 1880: 50–2. Lit. (13) (Just 8[1]: 190).—(15) Müller, Alpenblumen 162–3. 1881. —(16) Mez, Geschlechtsänderung einer Weide. Deutsch. bot. Monatschr. **1**: 93. 1883. *S. purpurea × viminalis.* (Just **11**[1]: 483)—(17) Müller, Fertilization of Flowers 524–6. 1883.—(18) Heinricher, Beiträge zur Pflanzenteratologie und Blütenmorphologie. Sitzber. d. K. Akad. d. Wissensch. Wien **87**: 1883. *S. caprea*, androgynous catkins. (Just **11**[1]: 483).—(19) Müller, Die Stellung der Honigbiene in den Blumenwelt III. Deut. Bienenzeit. **39**: 157–61. 1883. (Just **11**[1]: 476).—(20) Loew, Beobachtungen über den Blumenbesuch von Insekten an Freilandpflanzen des botanischen Gartens zu Berlin. Jahrb. bot. Gartens Berlin **3**: 82, 274, 276. (14, 72, 74). 1884.—(21) Warming, Om bygningen og den formodede bestövningsmaade at nogle grönlandske blom-

ster. Oversigt over d. K. D. Vidensk. Selsk. Forhandl. **1886**: 116, 131, 156.—(22) Pax, Salicaceæ. Engler u. Prantl. Die nat. Pflanzenfamilien. 14: 33. 1887. (Just **16**[1]: 563).—(23) Bulman, The bee and the willow. Sci. Gossip **1889**: 130.—(24) Kerner, Die Bedeutung der Dichogamie. Oest. bot. Zeitschrift **40**: 2-3. 1890.—(25) Kerner, Pflanzenleben **2**: 187, 311-12. 1891. Several spp. (Just **17**[1]: 532).—(26) Verhoeff, Blumen und Insekten der Insel Norderney. Nova Acta d. Kais. Leop. Carol. Deutsch. Akad. d. Naturf. **61**: 63-8. 1893.—(27) MacLeod, Over de bevruchting der bloemen in het Kempisch gedeelte van Vlaanderen. Bot. Jaarboek **6**: 129-33, etc. 1894. — (28) Loew, Blütenbiologische Floristik des mittleren und nördlichen Europa sowie Grönlands. 1894. (11 spp).—(29) Knuth, Blumen und Insekten auf den Nordfriesischen Inseln 131-2. 1894. *S. repens.*—(30) Weed, Ten New England blossoms and their insect visitors. 1-17. 1895. *S. discolor*, visitors, etc.

IRIS Tourn.—In this genus we find regular trilateral nototribe flowers. Each sepal, with a stamen and a style-division, is modified into a form which is almost a functional equivalent of a specialized flower such as we find in the Scrophulariaceæ, etc. The form of the style serves to determine the kind of insect pollinators and secures the application of the pollen to the insect's back. Kerner (5, 23) mentions the style of *Iris* as serving to protect the pollen, without, however, showing the probability of this having anything to do with its development.

Except in the single case mentioned below, the flowers are adapted to bumblebees, but are also visited by other large bees, such as *Xylocopa* (Delpino 6), and in this country by *Synhalonia*. *I. pseudacorus* (Müller 4) presents an interesting case of what Errera and Gevaert (11) call *dientomophily*—having one form adapted to bumblebees and another adapted to *Rhingia rostrata*, a Syrphid fly. The only other case as yet recorded is that of *Aconitum lycoctonum*, observed by Aurivillius (see Ludwig 19, 25), which has one form visited by bumblebees and another visited by butterflies. Gibson (28) in an account of the blue-flag, accompanied by a figure evidently of *I. versicolor*, implies that *Iris* in general is adapted to bumblebees and large flies. "A large fly" is a rather loose synonym for *Rhingia rostrata*.

Iris has sometimes been used as a type of hercogamy (ercogame contingente, Delpino 6), but *I. sibirica* has been shown to be proterandrous (Dodel Port 24, Loew 30). It will be seen below that *I. versicolor* is also proterandrous to some extent. Meehan (9) records a case in which *I. virginica* is said to have proved fertile under a net.

IRIS VERSICOLOR L. Larger blue flag.—This flower is described by Professor Goodale in "Wild Flowers of America," 32–35, and is there illustrated by a drawing by Isaac Sprague.

Newly opened flowers show the anthers dehiscent, but the stigmatic lobe is so closely appressed to the summit of the style that the true stigma is not touched by a bee entering the flower. Then in the early stages the tip of the anther lies against the stigma lobe and prevents its being reflexed. Later the style lengthens and the lobe loosens so that the true stigma may be touched. From the above it will be seen that the flower shows a tendency to proterandry.

The flower is adapted to long-tongued bees I have seen it visited by *Bombus americanorum* F. ♀, *B. pennsylvanicus* DeG. ♀, and *Synhalonia frater* Cr. ♂♀, ab. I have also seen a beetle, *Trichius piger* F., enter the flower so as to effect pollination, but this insect cannot reach the nectar. Sometimes butterflies obtain the nectar in an illegitimate way by backing down to the base of the flower and inserting their proboscides between the bases of the "falls" and the style divisions. *Chrysophanus thoe* B.-L. and *Pamphila peckius* Kby. were observed stealing the nectar in this way.

The flowers bloom from May 20th to June 14th.

In New Hampshire, Weed (31) saw the flowers visited by bumble-bees, of which the most abundant species was *Bombus terricola*, and occasionally by some smaller bees. A more frequent visitor was "a good-sized syrphid fly—apparently a species of Rhingia." Several species of skippers (Hesperidæ) and Sphingidæ stole the nectar from the outside, as described above, *Hemaris thysbe* sometimes sucking in the legitmate way.

On the pollination of *Iris* see:

(1) Sprengel, Das entdeckte Geheimniss. 20, 43–4, 69–79. 1793. *I. pseudacorus, xiphium, germanica, sibirica.*—(2) Hildebrand, Geschlechtervertheilung bei den Pflanzen 59. 1867.—(3) Axell, On anordningarna för de fanerogama växternas befruktning 114. 1869. *I. pseudacorus*—(4) Müller, Befruchung der Blumen 67–70. 1873. Fertilization of Flowers 543–7. 1883. *I. pseudacorus.*—(5) Kerner, Schutzmittel des Pollens 12. 1873.—(6) Delpino, Ulteriori osservazioni Pt. II. fasc. 2. Atti d. Soc. Ital. d. Sci. Nat. in Milano. **16**: 196, 201, 217, 220, 235, 263, 282, 340. (48, 53, 69, 72, 87, 115, 134, 192) 1873. **17**:—(203–4, 247). 1874. *I. aphylla, viscaria, germanica, xiphium, halofila, graminea, florentina, pseudacorus.*—(7) Gray, Botany for young people. II. How plants behave 21, 25. 1875.—(8) Lubbock, British wild flowers in relation to insects 176. 1875. *I. pseudacorus.*—(9) Meehan, On self-fertilization and

cross-fertilization of flowers. Penn Monthly, N 1876. Sep. pamphlet (4). 1877.—(10) Delpino, Dicogamia ed omogamia nelle piante. Nuovo Giorn. Bot. Ital. 8: 143. 1876.—(11) Errera et Gevaert, Sur la structure et les modes de fecondation des fleurs. Bull. Soc. bot. de Belgique 17: 149. 1878. (Just Bot. Jahresbericht 6[1]: 310)—(12) Hildebrand, Die Farben der Blüthen in ihre jetzigen Variation und früheren Entwickelung 36. 1879. (Just 7[1]: 110)—(13) Dodel-Port, Die Liebe der Blumen. 4, 5: 185–240. 1880. (Just 8[1]: 183)—(14) Gray, Structural Botany, 230. 1880. *I. pumila.*—(15) Focke, Nägeli's Einwände gegen die Blumentheorie, erläutert an den Nachtfalterblumen. Kosmos 14: 295. 1884. Just 12[1]: 668)—(16) Leow, Beobachtungen über den Blumenbesuch von Insekten an Freilandpflanzen. Jahrb. Bot. Gartens Berlin 3: 84, 96 (16, 28) 1884. *I. xiphioides, germanica, sibirica.*—(17) Licopoli, Sull polline dell' Iris tuberosa ed altre piante. Rendic. Accad. Sci. Fis. e Mat. Napoli 24:—1885. [No. 8.]—(18) Licopoli, Le pollen de l' Iris tuberosa. Journ. de micrographie 1886: No. 2.—(19) Ludwig, Ein neuer Fall verschiedener Blütenformen bei Pflanzen der nämlichen Art, und ein neues Kriterium der Schmetterlings-und Hummelblumen. Biol. Centralblatt 6: 24. 1887. (Just 15[1]: 426)—(20) Licopoli, Sull polline dell' Iris tuberosa. Atti d. r. Acad. d. Sci. Fis. e Mat. II. 2:—1888—(21) Pax, Iridaceæ, Engler und Prantl, Die nat. Pflanzenfamilien 10 u. 17: 140–1. 1888. (Just 16[1]: 554)—(22) Loew, Beiträge zur blütenbiologischen Statistik. Verh. Bot. Ver. Prov. Brandenburg 31: 43. 1890. *I. sibirica.*—(23) Kerner, Pflanzenleben 2: 93, 111, 173, 197, 247. 1891. *I. germanica, odoratissima* etc. (Just 17[1]: 528)—(24) Dodel-Port, Zur Kenntniss der Befruchtungserscheinungen bei Iris sibirica. Testsch. z. Feier d. 50 Jahr. Doctorjubiläums der Herren Nägeli u. Kölliker. 1891.—(25) Ludwig, Zur Biologie der. phanerogamischen Süsswasserflora (64) Zacharias, Das Thier- und Pflanzenleben des Süsswassers. 1891.—(26) Mac Leod, De Pyreneeënbloemen en hare bevruchting door insecten 306. 1891. *I. pyrenaica.*—(27) Mac Leod, Over de bevruchting der bloemen in het Kempisch gedeelte van Vlaanderen. Bot. Jaarboek 5: 168, 315. 1893. *I. pseudacorus.*—(28) Gibson, The welcomes of the flowers. Harper's Monthly 88: 560. Mr 1894.—(29) Dodel-Port, Biologischer Atlas der Botanik. Serie "Iris." 1894. *I. sibirica*, plates and text. (Knuth Bot. Centralblatt 58: 95)—(30) Loew, Blütenbiologische Floristik 64–5, 346 391. *I. xiphioides, pseudacorus, sibirica.* 1894.—(31) Weed, Ten New England blossoms and their insect visitors 98–104. 1895.

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The nomenclature question.

Some inconsistencies in plant nomenclature.

In a recent unpublished letter a prominent botanist calls attention once more to an argument that has often been made use of by the opponents of the so-called "reform" movement in botanical nomenclature: namely, that a motive, if not indeed the prime motive, for all this upsetting of names is to be found in the desire of the reviser to append his own name to all possible combinations of genera and species; in other words, that the sole end and aim of this nomenclatorial agitation is the theoretical opportunities it gives for incompetent writers to juggle with the names of our plants with the purpose of constituting themselves the authority for as many as possible. As a matter of fact nothing could have been farther from the minds of the nomenclature committee than this feature; and it was largely to obviate just such a possibility that the reform movement originated. By setting an initial date logically fixed at the beginning of binomial nomenclature behind which it is agreed not to go, and referring each species to the oldest subsequent name, the matter becomes fixed for all time. It is unfortunate that it is found necessary to change so many of our plant appellations, but when once so changed in accord with this logical principle, we shall have, it seems to me, a practically stable system of nomenclature. Other departments of biology have long since found it necessary to adopt similar rules, and their experience proves conclusively that it is a reform which reforms. The American ornithologists, for example, have been obliged to make less than one per cent. of corrections during the ten years' application of their code, and not one of these corrections was due to mere personal opinion; the nomenclature of North American birds is therefore practically stable, and I can see no reason why the botanists may not consequently hope for a similar fixation of plant names.

In order to show that the principle is open to criticism which regards the last author of a combination of genus and species as more important than the original namer of the same plant, I take the liberty of citing a number of examples. In the Synoptical Flora of North America **1**²: 397–407, the genus

Cnicus is found to embrace forty-two species and varieties. Of these, Gray is given as authority for no less than thirty-two; but by looking through the synonymy it appears that fifteen of the names, or nearly fifty per cent., had been given previously by other authors, as Nuttall, Muhlenberg, Hooker, Engelmann and De Candolle. Thus *Carduus undulatus* Nutt., 1818, becomes *Cnicus undulatus* Gray, 1874; *Cnicus discolor* Muhl., 1804, becomes *C. altissimus* var. *discolor* Gray, 1883, etc. The same practice may be observed in Watson's treatment of Lesquerella elsewhere, in which twenty-four out of thirty-five names credited to him had been previously given by other authors. All right and title of the original discoverer of a species thus disappears.

Another step in the working of this principle is shown in the recently issued fascicle 1 of volume **1,** part 1 of the Synoptical Flora, where the transferred species or varieties are followed by the abbreviations "n. sp." or "n. var." as the case may be. Thus we learn that *Clematis Pitcheri* var. *Bigelovii* is a "n. var." notwithstanding the fact that *C. Bigelovii* was described by Torrey in 1856! *C. Pitcheri* var. *filifera*, another "n. var." was described as *C. filifera* by Bentham in 1848. *C. verticillaris* var. *Columbiana* Gray, n. var. 1895, was described originally by Nuttall in 1834 and was made a "new species" again by Torrey and Gray in 1838. *Eutrema Eschscholtzianum* Robinson, n. sp. 1895, is *Aphragmus Eschscholtzianus* Andrz., 1824, while *Braya humilis* Robinson, n. sp. 1895, is *Sisymbrium humile* C. A. Mèyer, 1831. It is unnecessary to multiply examples. To my mind it does not seem probable that the practice of placing one's name after a species is likely to be more abused by the advocates of sound nomenclature than it has been in the past by the adherents of conservatism. It has usually been the custon to append "n. sp." or "n. var." only to species or varieties that are described for the first time as new to science, although the same abbreviations have occasionally been used where it has been found necessary to give a new name to a previously described plant, instances of which may be found in this same fascicle of the Synoptical Flora. This is the usage throughout the whole range of biology, without, so far as I can find an exception. If this innovation should ever become general, some other method of designating species and varieties that are really new will have to be devised, since the old familiar practice will have lost its force.[1]

The facts in the case, it seems, are simply these: The proposition that the author who makes "the first correct combination" of genus and species is entitled to more credit than the original discoverer of that species, cannot be maintained. Upon this point the committee appointed by the British Association to prepare a code of nomenclature makes the following statement:

". . . We conceive that the author who first describes and names a species which forms the groundwork of later generalizations possesses a higher claim to have his name recorded than he who afterward defines the genus which is found to embrace that species, or who may be the mere accidental means of bringing the generic and specific names into contact. By giving the authority for the specific name in preference to all others, the inquirer is referred directly to the original description, habitat, etc., of the species, and is at the same time reminded of the date of its discovery."

This committee numbered Darwin, Henslow, Wallace, Babington, J. D. Hooker, Balfour and Bentham among its members.

To the statement that preference should be given to the referrer of the species to its proper genus on the ground that "it requires greater knowledge of the structure and relationship of species to properly classify them than to simply name and describe them," the code of nomenclature adopted by the American Ornithologists' Union says, "But it often happens that the authority for the combination of names used is not that of the classifier, but of the author who merely 'shuffled names,' or worked out the synonymy in accordance with nomenclatural rules, and has had nothing to do with the correct allocation of the species."

The concurrence of opinion is, therefore, to the effect that the name of the original author of a species is an inseparable part of the specific name, and should go with it no matter what its vicissitudes may be, not only as a matter of simple justice, but from the standpoint of historical accuracy. This so-called "correct combination" is a personal equation and

[1]Since the above was written Prof. Bailey has, unfortunately it seems to me, adopted this innovation and writes "*n. sp.*" after his *Carex Arkansana*, which had been described as *bona fide* new as a variety in 1888.

can never be a fixed quantity. It needs but a glance at our manuals to show that generic and specific limitations are variously understood by writers, and who shall be entitled to say which is the truly "correct" combination? Indeed the authority for the last combination is regarded as of so little importance by American ornithologists that they omit it in writing the names of North American birds. Personally, I prefer the double citation, for then the history of the species becomes complete. The namer of the species and the authority for its present combination both receive the recognition justly due them.—F. H. KNOWLTON.

Botanical nomenclature.

Perhaps enough has been said on the subject of botanical nomenclature, yet I would like to offer some comments on certain phases of it that have been made prominent by some of the advocates of the Rochester and Madison rules.

It seems to be taken for granted by them that the signers of the Harvard circular were, and are, influenced by considerations of sentiment and prejudice in opposing the so-called reform in botanical nomenclature, whereas the contrary is the truth.

To assert that such men as Dr. Farlow, Prof. Eaton, Dr. Goodale and Dr. Robinson, and I might very properly add Dr. Gray and Sereno Watson who when living were in sympathy with the spirit which subsequently found expression in the Harvard Circular, would permit themselves to be influenced by mere prejudice and sentiment in such a matter is quite as discreditable to those eminent botanists as it is to those who make the assertion. Rather it is that the signers of that Circular believe with the late Prof. Eaton, who wrote me to this effect only a short time before his fatal illness, that the proposed methods of reform, so-called, would tend to increase rather than to diminish confusion.

By far the ablest paper, the fairest and most courteous that has yet appeared in defense of the new rules is that published by Lester F. Ward in the *Bulletin* of the Torrey Botanical Club in July, 1895, yet Mr. Ward certainly errs in assuming that the signers of the Harvard Circular are influenced by mere sentiment and prejudice, or a "personal disinclination to incur the annoyance of accustoming themselves to a new set of names." Among those signers of whom I have knowledge and acquaintance the contrary is true. But one may well pause to consider the deplorable results likely to accrue from the ambitious revisions of the time-honored work of our greatest botanists through the opportunities opened up by the new system before approving of a method which tends to increase confusion by the multiplication of needless synonyms.

If Mr. Ward's suggestion of doing away altogether with authoritative names could be carried out it might perhaps do away with much of this objection by removing at least one motive for it, but it is doubtful if the suggestion is practicable, or desirable if practicable. An author's name has a certain historic significance and value. It not only furnishes a means for reference, but it is an indication of the direction in which one is to look for a knowledge of the plant's history. To advocate its removal on the grounds of "style" as Mr. Ward does, is to appeal directly to the purest sentiment; for what is style but sentiment, and what has science to do with sentiment? Here, it seems to me Mr. Ward is somewhat inconsistent. He accuses the signers of the Harvard Circular with being influenced by sentiment and prejudice, which we deny, and then suggests a change which has for its very foundation the purest sentiment possible whose legitimate field is the realm of literature only.

Again Mr. Ward errs when he says that "principle is cast aside for sentiment, and because Swartz' name of Aspidium happens to be in common use among fern gatherers (why not botanists?) we are enjoined from taking up the perfectly valid designation Dryopteris given years previously by Adanson." On the contrary the argument here is all against him, and, on their own grounds, of those who attempt to substitute Dryopteris for Aspidium. There is no sentiment at all about it. It is a practical application of the principles of priority as I understand them, as they were held by Prof. Eaton, and all botanists who adhere to Swartz' genera.

When Swartz elaborated the genus Aspidium he originated an entirely new order of things back of which there is absolutely nothing entitled to consideration. "Swartz was the first to reduce fern genera to anything like systematic order," wrote Prof. Eaton to me not long ago, and his work has received the endorsement of nearly a century; of what value as against it, is the obscure, insufficient and unscientific reference merely of Adanson, who himself borrowed the name Dryopteris from Dioscorides of the first century?

I have alluded to Mr. Ward's paper because it represents the best of what I am criticising. It is in fact the strongest and best defense of the Rochester and Madison rules that I have seen, and I doubt if an abler can be made; but I feel obliged to dissent from its conclusions though gladly bearing witness to the admirable spirit of courtesy with which it is so thoroughly imbued.

The argument however which he draws from analysis between searching for the parentage of a lost child and a lost plant, though ingenious and taking, is like a two edged sword that cuts both ways, or a boomerang that rebounds upon its thrower, and any such analysis is false and misleading with little or no application to botanical science. If this is not so, one might offer a similar analysis with an entirely different result. For example: the new nomenclature insists upon the specific name being in itself the name of the plant although such is not the fact. John Smith has two sons, William and John, either one of whom under certain conditions, and at certain times may properly be called Mr. Smith, or, in the privacy of their own homes, William, or John; but when it comes to public recognition it becomes necessary to designate either, or both, as the case may be as William Smith, John Smith, Jr., the abbreviation being affixed to distinguish the younger from the elder John, or it may even be necessary to add the residence, even to the detail of street and number in order to distinguish the sons of John from the sons of Samuel before the absolute identity of either of the Smiths can be conclusively established; so that a knowledge of the full name is necessary to fix the personality of each individual for a certainty.

Now among the ferns there are many distinct species bearing precisely the same specific name, so that if the specific name alone is the true name it would obviously be impossible to distinguish the different individuals by their names alone. The mere statement of this is sufficient to show the necessity for some other distinguishing appellation and the superiority of the generic name. The fern is an Acrostichum, an Asplenium, a Myriophyllum or a Botrychium with or without its specific name, but not a lanceolatum, a Wrightii or a Lindeni isolated from the generic. The two names are inseparable. Otherwise there could be no good reason for fixing upon the beginning of the Linnaean binomial system for plant nomenclature, and we might as well go back to the very beginning of plant names if we want to be absolutely just and "render unto Cæsar the things that are Cæsar's." On this point no less an authority than Bentham declared that "the specific adjective of itself is not the name of a plant," and that "for a species the combination of the substantive and adjective is absolutely necessary." It follows from this that a plant is not correctly named, until it receives its proper generic and specific name in combination.

But perhaps the strongest objection to the insistence on the use of the specific name under any and all circumstances is the absurdity to which it leads in the use of homonyms. In a reply which I wrote to Mr. Stearns' paper on Nomenclature in the *Bulletin* of the Torrey Botanical Club, but which was withheld from publication, I pointed out that the legitimate outcome from the proposed reform, if carried out, must lead to the adoption of what DeCandolle, Bentham, Dr. Hooker, Dr. Gray and such eminent botanists had always regarded as too absurd for consideration, as it was not thought probable that any botanist would adopt anything of the kind. Yet it has come about exactly as I said and we are treated to such absurd combinations as Phegopteris Phegopteris, Scolopendrium Scolopendrium, and such startling propositions as Polypodium polypodioides—a Polypodium that looks like a polypodium! What a wonderful revelation of scientific knowledge and information that is, to be sure, and how helpful it must be to the average collector in the field!

I have elsewhere stated my willingness to sacrifice my own personal views and accept without reservation any code approved by representative botanists of all countries in an international congress. National pride, the heritage from generations of American born ancestors, would naturally incline me to prefer methods originating in American atmosphere, but science is cosmopolitan and knows no boundaries. She seeks only for the truth, and the best, come from where it may, and therefore it has seemed to me that the so-called Vienna rules proposed by the German botanists at Berlin offer a much better basis for permanent agreement than our own and I would be glad to see them, or similar ones prevail.—George E. Davenport.

Some remarks on nomenclature.

I cannot see how the nomenclature question can otherwise be settled than by a Paris congress in the year 1900 with four or five years international preparation for the reformed Paris Codex.

But the Société botanique de France needs to be encouraged by foreign botanists to arrange for such a congress, inasmuch as the nomenclature questions are the least treated by French botanists, and the Paris Codex of 1867 was more the work of foreigners.

It seems also that the French Botanical Society lacks the funds to prepare properly for such a congress; in your country more is spent for science by private people than in any other land, so it is to be hoped that somebody will offer money promptly for that purpose, helping thereby to establish an international nomenclature of plants.

I did not mix after 1893 in the United States botanists quarrels over nomenclature, considering them as home quarrels. But I may say that wrong enough has been done on both sides, and I proved only in 1894 that the two specific North American rules, accepted so promptly in Madison before the beginning of the congress there, were very bad. See my *Nomenclaturstudien* in Bull. Herb. Boissier. The BOTANICAL GAZETTE, although most conciliatory and impartial, did not print my figures, which convinced the European botanists about the harmfulness—if retroactive—of the two American rules, so I hope you will do it still. 1. "*Priority in place at all events*" from Linné's *Species Plantarum* 1753 causes the changing of at least twenty generic names and 4,600 specific names. 2. The rule: "*Once a synonym always a synonym*" is very bad if retroactive. I gave in my *Nomenclaturstudien* a list, made in a short time, of 200 generic names of personal derivation, which would thereby be changed with about 1,737 specific names. Surely for the whole system 300–400 more generic names would lose their *usual* names. For the future that rule is excellent; that is to say not for the "future difficult to define" but for each future case. If any one finds a name whose renewal is necessitated by priority, he shall not renew it, if a former homonym exists since the international beginning of our nomenclature. That is very easy to manage.

It is quite untrue as stated in another United States paper, that the so-called Vienna rules of 1894 were accepted in Vienna by the German and Austrian botanists. On the contrary they were rejected and left to a future congress, for which congress at Berlin, although proposed for 1895, nothing has been done or prepared, so far as I know, although I worked in the Berlin botanic museum till last October.—OTTO KUNTZE, *San Remo, Italy.*

Dates and references, and priority in nomenclature.

It does not seem too much to expect from those who would purify botanical nomenclature, that they should be themselves pure. But those who have had to do with comparing references with the originals, will be surprised at the enormous number of inaccuracies that pass current. A new reference book is required as badly as a purified nomenclature. In the preparation of the chapters to go with the plates in my "Flowers and Ferns of the United States," and its continuation, "Meehans' Monthly," I have tried to verify original references, and can say of my own personal knowledge that references to dates and authors are in a most deplorable condition.

I am just now at work on the two species of *Chimaphila*, *C. umbellata* and *C. maculata*. My good friend Conway MacMillan contends in the "Metaspermæ of the Minnesota Valley" that we must drop *Chimaphila* of Pursh (1814), and adopt *Pseva* of Rafinesque," Jour. Phys. **79:** 261. 1809. I turn to "Index Kewensis," and find it is "Jour. Phys. Sc." thus indicating that it may be an English title, but there is no such work. I try again and examine the work usually referred to as "Jour. Phys.," Desvaux "Journal de physique," and examine page 261, volume 79, but there is not a word about Rafinesque or botany. Looking again at "Index Kewensis," I suspect an error in adding "Science" to the title, and note that they give 1819 for the date, instead of 1809. Examining "Journal de Physique" for that year, I find a paper by Rafinesque entitled "Remarks critiques et synonymiques sur les ouvrages de MM. Pursh, Nutt.,"—and a host of others—"sur les plantes des Etats-Unis." These authors are handled without gloves, and one can hardly wonder at the coolness shown to him by his co-laborers. "*Ipomopsis* Mx., and *Ipomeria* Nuttall, are absurd." "*Ammyrsine* Pursh is an abominable name." *Mahonia* should be changed "as dedicated to a gardener who does not merit the honor." "*Lyonia* should be changed as it is too near *Allionia*." "*Epifagus* Nuttall, is an absurd name." The whole paper is simply a critique, with no pretension of describing anything. But there is a reference to "*Pseva.*" "*Chimaphila* Pursh is *Pseva* Raf. Obs., but the name of Pursh is better and more significant." This is all, and this is the authority of "Index Kewensis" for the name.

A clue is at length furnished by Rafinesque's own work "Medical Botany," under *Pyrola maculata.* "The genus must be divided into sub-genera: *Streptylia*, *Orthylia*, *Psiseva* and *Chimaphila.*" Under *Psiseva* he would only retain *P. maculata*, even as a subgenus. For this name he quotes Raf. 1808. Prof. MacMillan has *Pseva* 1809. I can find nothing in 1808 relating to it. But there is another reference, "Observations on some plants of the United States in Medical Repository for 1809." I cannot find this. If it be here that the name was first employed, we have Rafinesque misquoting his own date!

Just here comes in another matter: how far may we be justified in changing an evident error in orthography in an author's name? Those who are acquainted with Rafinesque's handwriting as I am, know how difficult it is to determine the individual letters, and how fond he is of abbreviations. It is no wonder the printer set up *Scoria* for *Hicoria.* In the article cited from Desvaux "Journal de Physique," Dr. Torrey is criticised through the chapter as Dr. Jorrey. He seems, however, generally, to accept these printed versions of his manuscripts. *Pachistima*, if it had been employed by Nuttall or Pursh, he would have characterized as "absurd" or "abominable," and suggested something else. Meisner corrected it subsequently to what Rafinesque's manuscript no doubt intended, *Pachystigma*, but no one follows it.

By the form *Psiseva*, which he uses in "Medical Botany," I have little doubt he intended to name this plant after its Indian name Pipsisewa, but that the printer in despair at the manuscript, rendered it Pseva, an "absurd and meaningless" name; or, likely as not, he may have writted P'seva.

But—and this is what I want to emphasize—ought not reformers to reform along the whole line, and not puzzle us in this way?—THOMAS MEEHAN.

BRIEFER ARTICLES.

LASIODIPLODIA E. & E., n. gen.—*With Plate V*.— Perithecia collected in a stroma, clothed with brown mycelium; basidia and sporules with paraphyses intermingled; otherwise as in *Diplodia*.

Lasiodiplodia tubericola E. & E., n. sp.—Perithecia globose 250–350μ (inner cavity 175–190μ), clothed outside with an abundant brown septate sparingly branched mycelium, stromatically connected in a small hemispherical erumpent tubercle about 1^{mm} diam. Sporules elliptical, short stipitate, hyaline and continuous at first, becoming brown and uniseptate; 18–22×11–14μ; not constricted; overtopped by filiform processes 45–55μ long, resembling paraphyses and springing with the basidia from the proligerous layer.

The above fungus was found on some sweet potatoes that were brought to the Louisiana Experiment Station from Java, in the spring of 1894. The potatoes appeared sound, and were planted a day or two after they were received. Failing to grow, they were dug up some ten days later, and were found to be rotting. The fungus causing the rot was sent to Mr. Ellis to be identified, and he pronounced it a new genus, giving it the name *Lasiodiplodia tubericola*.

Externally, sweet patatoes attacked by this fungus, show dark shriveled patches, over which are scattered little black pustules. The tissue within is slightly spongy, rather moist, and in color is a mixed olive-green and grey. The olive-green parts show an abundant, dark-brown, septate, branching mycelium running between and through the cells of the host (fig. 1). It may be added also, that the mature brown spores frequently show longitudinal striations (fig. 4).

As *Lasiodiplodia* has not been previously described, and the diseases of the sweet potato have been pretty thoroughly studied in the United States, it seems more than probable that the form is an imported one. Sweet potatoes brought from Java in February, 1895, were found affected by the same fungus when they were received at Baton Rouge, so in this case they could not have been infected from the soil at the Louisiana station.

Cultures of the fungus have been undertaken, looking to the working-out of its life history.—IDA CLENDENIN, *The Girls' High School, Brooklyn, N. Y.*

EXPLANATION OF PLATE V.—Fig. 1.—Mycelium of *Lasiodiplodia tubericola* passing through and between the cells of the host.

Fig. 2. Perithecium of same. Paraphyses and immature spores within. Three mature spores without.

Fig. 3. Portion of perithecium more highly magnified.

Fig. 4. Mature spores and external brown mycelium.

CURRENT LITERATURE.

Mosses and ferns.

Dr. Campbell's long continued studies upon the ferns and liverworts have prepared him admirably for the preparation of the volume on the Archegoniatæ which has recently been issued.[1] This is beyond question the most important morphological work yet published by an American botanist and the publishers have given it a dress worthy of it.

In this work Professor Campbell brings together a large amount of heretofore scattered information regarding these plants, not a little of which he has himself contributed. The first 150 pages are devoted to the Hepaticæ, less than 70 to the Musci, and 300 to the Pteridophyta. In this distribution of space the author has done wisely, giving to the polytypic liverworts a fuller discussion than the much less varied mosses, a course more necessary as the liverworts are considered by Dr. Campbell in all probability the progenitors of both mosses and ferns. While this proportion is a perfectly just one, it is also one which accords with the author's predilections and the length corresponds curiously with the strength of treatment.

It is impossible to criticise this excellent work in detail. It must suffice to say that the full and lucid account of the structure and development of archegoniate plants will be most helpful, not only to students of these groups, but also to those teachers who, because their special studies lie in other lines, need such a compendium as this to which they may turn with confidence. For the book is compendious rather than philosophical. The author seems to have avoided of set purpose any extended theoretical discussions. He has, however, given us admirable condensed statements of the affinities of the most important groups outlining divergent views when they exist. (It may be here noted in passing that by an error, apparently typographical, on p. 513, Bower's theory is misstated.)

One of the most important features of the book is that the author has been able by reason of his study of a considerable number of American species to use these in illustration of morphological points. The use of Funaria hygrometrica to illustrate the structure of the stegocarpous mosses is therefore something of a disappointment, for

[1] Campbell, D. H.—The structure and development of the mosses and ferns (Archegoniatæ). 8vo. pp. viii + 544. figs. 266. New York and London: Macmillan & Co. 1895.

this moss has been exploited until the very name is a weariness to the flesh.

Dr. Campbell has laid us under obligations further in publishing a large number of new drawings, whose freshness commends them as well as their natural look. Many of these leave nothing to be desired, especially the outline drawings, but some are really too sketchy and crude to be found in such good company. The re-drawing of illustrations from other papers is not usually well done. One would rather see Luerssen's beautiful figures of Salvinia, for instance, than these pen sketches of them.

We have more serious fault to find with the book on the score of terminology than any other. The homologies among the archegoniates are so plain and well-known that it seems a pity to continue to encumber terminology with words whose existence only emphasizes dissimilarity. Dr. Campbell adopts gametophyte and sporophyte, it is true, to designate the sexual and non-sexual stages, but he continues to use sporogonium and prothallium in a way that would be confusing to a novice. For example: "The most striking difference, then, between the sporogonium of Anthoceros and the sporophyte of the simple pteridophytes," etc., p. 513. The subheads are not only everywhere particularly illogical but also lend their aid to create confusion of ideas. For example, under the Marattiaceæ, there is a subhead, *the gametophyte*, under which the sporophyte is also described; under Isoetaceæ the subheads are the gametophyte, the embryo, the sporophyte, the sporangium.

This failure to discard obsolescent terms leads naturally to the occasional inculcation of some antiquated ideas. E. g., p. 5, "In the bryophytes, as a class, the gametophyte is more important than the sporophyte, the latter being, physiologically, merely a spore-fruit . . ." This is very questionable from the physiologists' standpoint and the less said about such analogies in morphological treatises the better.

If we may now express regret that the author did not provide a good index—something more than a mere register of names—our unwelcome task of pointing out the few blemishes in a most praiseworthy book shall be concluded.

The soil.

Since land plants are so largely influenced in form and function by the soil a book upon the physics of the soil has great interest for botanists, and all the more when the subject is treated from the point of view of the agriculturist. Professor King's researches at the University of Wisconsin upon the soil water have led him to a general study of soil physics and at Professor Bailey's suggestion he has prepared this book as the first volume of a "Rural Science Series" (L. H. Bailey, editor, issued by Macmillan & Co.) which is to be an authoritative series of readable monographs treating rural problems in the light of underlying principles. It is particularly appropriate that the initial volume of the series[1] should discuss the soil, upon which most "rural problems" depend.

The book treats concisely and interestingly the nature, functions, origin, texture, composition, and kinds of soil; nitrogen of the soil; the distribution of roots; relation of air and water to soil; temperature; drainage and irrigation; and the physical effects of tillage and fertilizers. In most of these chapters there is much to interest the physiologist and the book may be commended as a necessity for the library.

Minor Notices.

Just's Botanischer Jahresbericht is so well known that it seems scarcely necessary to call attention to its value. The twentieth volume has recently been completed.[2] This Annual Report endeavors to give reviews every year of all botanical works, treating bacteriology and pharmacy only so far as these are of general interest to botanists. In producing this invaluable work of reference Dr. E. Koehne, the editor, is aided by several well known specialists. By giving abstracts hereafter in a more concise form, the Annual Report is to be reduced both in price and size. The completeness of this work is a consideration of so much importance for all botanists that the editor earnestly requests botanists in all countries to send him separates of all papers, especially of such as are not likely otherwise to be referred to in the Annual Report. Such contributions would permit more prompt publication and justify more reliance upon the Report. It is particularly requested to send everything to the editor's adddress: Professor Dr. E. Koehne, Friedenau-Berlin, Kirchstr. 5, Germany.

An annotated list of the aquatic phanerogams of Iowa has been distributed by Mr. R. I. Cratty[3] as a separate from the science bulletin of the State University of Iowa. It embraces eighteen genera and

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[1] King, F. H.—The soil; its nature, relations, and fundamental principles of management. 12mo. pp. xvi + 303. figs. 45. New York: Macmillan & Co. 1895. $0.75.

[2] Koehne, E.:—Just's botanischer Jahresbericht, systematisch geordnetes Repertorium der botanischen Literatur aller Länder. Berlin W., am Karlsbad 15. Gebrüder Borntraeger. Jährlich 40 m.

[3] Cratty, R. I.—Notes on the aquatic phenogams of Iowa. Extracted from Bulletin Lab. Nat. Sci. State Univ. Iowa **3:** 136–152. Dec. 16, 1895.

forty-one species. Nine species are added to the state flora as heretofore listed in Arthur's "Contributions to the flora of Iowa" and Hitchcock's "Catalogue of the Anthophyta and Pteridophyta of Ames." They are the following: *Echinodorus rostratus* Engelm., *Lophotocarpus calycinus* (Engelm.) J. G. Smith, *Potamogeton heterophyllus* Schreb., *P. major* Morong, *P. Nuttallii* C. & S., *P. pusillus* L., *P. spirillus* Tuck., *Sagittaria Arifolia* Nutt., and *Wolffia brasiliensis* Wedd. It is a most excellent piece of local botanical work. The data are very full and so critically considered that they can be taken as authoritative. Local lists of this kind are most welcome, and their number should increase.

A CHARMING little book is that Professor W. W. Bailey has written about Rhode Island wild flowers.[1] It has the breath of the woods about it, especially as we follow the author to the "favored spots" where grow the floral prizes. Like the trumpet to the war horse, the book stirs us and arouses the desire to wander afield again and gather the treasures which used to awaken our earlier enthusiasm. With the entertaining chapters go some of scientific value which record Rhode Island ferns and trees; but the book is primarily for the nature lover.

A MOST COMMENDABLE and serviceable work has just been published on the bibliography of Italian botany by Prof. P. A. Saccardo.[2] Brief biographical items and the titles of chief works of 1434 Italian and 287 foreign writers on the botany of the country are given. Whatever has been anticipated in Pritzel's *Thesaurus* is referred to and not duplicated. The work also includes notes on all public, private and educational botanic gardens, of which the number is surprisingly large, including a list of their publications. Some other matters also find place.

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[1] Bailey, W. W.—Among Rhode Island wild flowers. 12mo. pp. xii + 105, pl. 3. Providence: Preston & Rounds. 1895.

[2] Saccardo. P. A.—La botanica in Italia; materiali per la storia di questa scienza. 4to. pp. 236. Venezia, 1895. 10 fr.

NOTES AND NEWS.

THE PIGMENT of the negro skin, also found in white races to a much less extent, is believed (Abel and Davis in *Science* **2**: 110) to hold some chemical relation to chlorophyll.

A KEY TO THE WOODY PLANTS of Mower county, Minnesota, has been published by Mr. K. C. Davis. It is intended to be used in the winter time, and embraces fifty-two species of ligneous plants.

THE BOTANICAL LIBRARY of Mr. C. G. Lloyd of Cincinnati numbers 3,000 bound volumes and 1,000 pamphlets, and contains many choice and valuable works. It receives a large number of additions yearly.

TOXICODENDRIC ACID, which was studied by Maisch in 1865, and since that time generally accepted as the poisonous principle of Rhus Toxicodendron or poison ivy, is now said by Pfaff (*Science* **2**: 118) to be identical with acetic acid, and that the poisonous substance is an oil, which he calls toxicodendrol.

MR. EDWARD C. JEFFREY, of the University of Toronto, finds that Erythronium Americanum shows polyembryony which is exactly homologous with that common among gymnosperms. The fertilized egg produces a mass of cells which produces on its free surface two, three, or even four embryos. Of these only one persists in the ripened seed. Cf. *Annals of Botany* **9**: 537. D 1895.

A CORRECTION.—In the GAZETTE for May, 1894, under the title of "Notes from Vermont," I stated that *Aster tardiflorus* L. had been collected in Smuggler's Notch. This was determined for me by competent persons, but the determination was incorrect. The plant in question is a form of *A. Novi-Belgii* L. The *Myriophyllum scabratum* Mx. proved to be *M. Farwellii* Morong.—A. J. GROUT, *Columbia College, N. Y.*

COLLECTIONS FROM the western coast of Greenland are reported upon in the *Proceedings of the Philadelphia Academy of Sciences* by Mr. Wm. E. Meehan (April, 1892) and again by Mr. Theo. Holm (Feb. 1895). As this insular region possesses much interest to the geographical botanist it is worthy of note that the plants on which these reports are based are deposited in the Academy of Sciences in Philadelphia and a partial duplicate set in the national herbarium at Washington, and that the second paper supplements the first by correcting a number of determinations.

AN ADDITIONAL donation of $10,000 for the endowment of the New York Botanic Garden has recently been received from Mrs. Esther Hermann. This garden, if it continues to receive the attention from wealthy residents of New York that it has so far received, is likely to be within a few years the foremost botanic garden in America, and one of the largest in the world. The work of constructing roads and erecting buildings will begin in the spring. About 250 species of plants in addition to those now growing on the grounds have been placed in a temporary nursery, and a gift of $5,000 worth of plants from Mr. James A. Pitcher is available at any time.

RAMIE, THE FIBER derived from Boehmeria, is the material of the ancients, which has been called linen and cotton by translators, according to Mr. C. O. Boring, who writes in the *Dry Goods Bulletin* (**18**: 12) for Jan. 1, 1896. The fiber is an extraordinarily pure cellulose exceeding cotton, and by improved methods of preparation becomes a rival to silk in luster and susceptibility to color. The fiber is long and very strong, and is capable of being woven into cloth of almost any texture. The native B. cylindrica has a good quality of fiber, but the species usually cultivated is B. nivea. The latter is grown in Louisiana, Texas and California, and as a manufactured article reaches this country from China under the name of China grass cloth.

THE PHARMACEUTISCHE RUNDSCHAU has changed its name to the *Pharmaceutical Review*, and is hereafter to be published chiefly in English, though not to the exclusion of German articles. The veteran editor, Dr. Fr. Hoffmann, retains his connection with the *Review*, but has associated with himself as the active editor Dr. Edward Kremers, Director of the School of Pharmacy of the University of Wisconsin. The direct cooperation of seven of the leading pharmacists and chemists has been secured and their names appear upon the title page. The place of publication also changes from New York to Milwaukee, where the Pharm. Review Publishing Co. has charge of all business matters. The *Review* has not only maintained a high scientific standard but has in the past kept itself absolutely free from commercial influence, a policy which will no doubt be consistently adhered to in the future. Botanists will find much in the pages of the review of most direct interest and we cordially commend it to our readers.

TRABUT[1] describes two modes in which *Aristida ciliaris* Desf. is protected against creeping insects. The plant inhabits the desert of Sahara and shows there the development of a ring of long, divaricate hairs at the nodes, which prevents creeping insects, ants, etc., from reaching the inflorescence. The same species has lately also been found by Ain Sepra in South Oran, but represents here a singular variety, being destitute of the hairy ring, but showing a secretion of a viscid substance, which covers a part of the internodes near the node. The other part of the internode is very smooth as in the typical plant. It is curious if this plant should, really, have been able to protect itself against the ants, while other species as *A. pungens* from Sahara and *A. oligantha* from North America are said to be eagerly sought by the ants, which should gather their grains. The author says that *A. oligantha* is called "blé de fourmis" in Texas, a fact that is not recorded in our agrostological works.—T. H.

PARASITIC FUNGI, as an index to the inner nature of plant hybrids, have been tested by Dr. Jakob Eriksson at the experiment station in Stockholm, Sweden, in a particularly interesting manner (*Botaniska*

[1] L. Trabut: *Aristida ciliaris* Desf. et les fourmis. Bull. de la soc. bot. de France **41**: 272. 1894.

Notiser **1895**: 251–253). Plants grown from seed received from Germany were attacked by rust, which proved to be *Puccinia dispersa* Eriks. & Henn., a species having two well marked physiological races, one maintaining itself on rye and the other on wheat. The plants on which it was now growing were supposed hybrids between rye and wheat, the crosses having been made by Dr. Rimpau of Schlaustedt, the previous season, and while looking in general much like wheat, had the elongated heads of rye. The uredospores from the rust on these supposed hybrids were sown on young rye plants (25 infections) and on similar wheat plants (26 infections). In fifteen days all the infected spots on the wheat plants showed characteristic pustules, while the rye plants remained entirely free, although the observations were continued for thirty-five days. The conclusion is inevitable that the presence of this particular race of rust showed that the supposed hybrid partook of the physiological nature of wheat and not of rye, whatever might be true of the morphological characters.

THE EXPERIMENT STATION bulletins containing botanical matter, which have come to hand since the last notice, are as follows: Some experiments with fungicides on peach foliage, by S. M. Bain (Tenn. vol. 8, no. 3); Effect of liming upon the development of potato tubers, by H. J. Wheeler, J. D. Towar and G. M. Tucker (R. I. no. 33), reaches the conclusion that lime upon sour soils increases the yield but also promotes the scab; Upon the effect of barnyard manure and various compounds of sodium, calcium and nitrogen upon the development of the potato scab, by H. J. Wheeler and G. M. Tucker (R. I. no. 33), a very full and important statement of the action of external conditions upon the growth of scab; Grape culture, by H. N. Starnes (Ga. no. 28) contains a brief account of fungous diseases and their treatment, black rot and root rot being considered far the worst; Notions about the spraying of trees, by L. H. Bailey (Cornell no. 101), enforces some fundamental ideas that must be kept in mind to obtain success in the use of fungicides; Treatment of currants and cherries to prevent spot diseases, by L. H. Pammel and G. W. Carver (Iowa no. 30), shows the efficiency of Bordeaux mixture; Squirrel-tail grass, Hordeum jubatum (Iowa no. 30), gives the results of much research, with a number of original illustrations; Studies of maple sap, by F. W. Morse (N. H. no. 32) is an interesting report on the flow of sap and the parts of the trunk from which it comes; Care of fruit trees with some reflections upon weeds, by L. H. Bailey (Cornell no. 102), gives some good advice not always kept in mind; The wild onion, Allium vineale, by R. L. Watts (Tenn. vol. 8, no. 2), an account of its distribution, habits and the methods of extermination.

THE ACADEMY OF SCIENCES of Iowa, Ohio and Indiana presented the following botanical subjects in their programs at the holiday sessions.

Iowa: Notes on the flora of western Iowa, by L. H. Pammel; Notes on grasses between Jefferson, Iowa, and the Rocky mountains in Colorado, by L. H. Pammel and F. Lamson-Scribner; Notes on chromogenic bacteria, by L. H. Pammel and R. Combs; Inoculation experiments with Gymnosporangium macropus, by F. C. Stewart and G. W.

Carver; Forest distribution in Iowa and its significance, and Notes on the problem of nomenclature as it appears in the Myxomycetes, by T. H. McBride; Some anatomical studies of the leaves of Sporobolus and Panicum, by Emma Pammel and Emma Sirrine; Perfect flowers in Salix, and Notes on the Iowa flora, by B. Shimek; A comparative study of the spores of North American ferns, by C. B. Weaver.

Ohio: List of white mildews in Cuyahoga, Erie and Medina counties, List of mosses and hepaticæ new to or rare in Ohio, Does Artemisia biennis live over winter, and Additions to the flora of Ohio and to those of certain counties, by Edo Claassen; A contribution to the flora of Fairfield county, and Formalin as a preservative of vegetable tissues, by E. M. Wilcox; Two new German handbooks of plant diseases, Some hitherto unlisted Ohio fungi, by Aug. D. Selby; Additions to the bibliography of Ohio botany, Distribution of the mistletoe in Ohio, Germination of seeds treated with fungicides, and The early Ohio botanists, by W. A. Kellerman; An analytical key to Ohio parasitic fungi, A freak of Cornus florida, and The parasitic fungi of Ohio, by F. L. Stevens; Flora of Erie county and the islands, by E. L. Moseley; The botanic garden and Institute at Leipzig, by G. M. Holferty.

Indiana: Botanical literature of the state library, and Microscopic slides of vegetable material for use in determinative work, by John S. Wright; Embryology of Hydrastis Canadensis, and Some determinative factors underlying plant variation, by Geo. W. Martin; The circulation of protoplasm in the manubrium of Chara fragilis, by D. W. Dennis; Flora of Turkey lake, by O. H. Meincke; Some beneficial results from the use of fungicides as a preventive of corn smut, by Wm. Stuart; Ratio of alcohol to yeast in fermentation, and Infection by bread, by Katherine E. Golden; Distribution of Orchidaceæ in Indiana, by Alice M. Cunningham; A new station for Pleodorina, by Severance Burrage; Report upon certain collections presented to State Biological Survey, Certain plants as an index of soil character, and Noteworthy Indiana phanerogams, by Stanley Coulter; Forms of Xanthium Canadense and X. strumarium, and An interchangeable clinostat of new design, by J. C. Arthur; Some notes on wood shrinkage, by M. J. Golden.

BOTANICAL GAZETTE

MARCH, 1896.

Contributions from the Cryptogamic Laboratory of Harvard University. XXXII.

Notes on cultures of Exobasidium Andromedæ and of Exobasidium Vaccinii.

HERBERT MAULE RICHARDS.

WITH PLATE VI.

Among the various species of Exobasidium there has been one described on *Andromeda ligustrina* characterized mainly by the large hollow distortions which it produces on its host. Peck, who is the authority for this species, has given the original description of it in one of his reports[1] and the few other references by different botanists are all brief or even limited to the citation of the name in local floras. Unlike *Exobasidium Azaleæ* Peck, which some consider a variety of *E. Vaccinii* (Fuckel) Woronin, *E. Andromedæ* Peck has never been questioned as a distinct species and this mainly on the character of the distortion it produces. It is true that the measurements of the spores as given by Peck are much larger than those of any other Exobasidium but in all the specimens examined by the writer, including those in exsiccatæ, no such large spores were found.

In order to determine something more about the nature of this fungus and to compare it with other species of the genus an investigation was begun at the suggestion of Professor Farlow with the intention of examining all of the species of Exobasidium available. Since it will be impossible for the writer to complete this work now, and since the results of the observations and experiments already completed are definite, though unfortunately somewhat incomplete, it has seemed best to publish, at the present time, what has been done.

[1] Report State Botanist N. Y. 26: 73.

The distortions caused by Exobasidium Andromedæ, which are much the largest of any caused by the Exobasidia, hang down as large, usually greenish, bag-like distortions from the smaller branches of the host, Andromeda ligustrina. As far as could be determined the distortions arise from the young buds, either leaf or flower buds, but usually the former. They are attached by a very small point and easily break off. In size the bags vary anywhere from five to six inches long by four across, to small distortions not over two inches in their longest diameter. The color, while often more greenish than other Exobasidia, sometimes is the characteristic pink or red that one sees in E. Vaccinii on Gaylussacia.

In structure the mature gall is hollow with comparatively thin walls which are supported by numerous more or less branched cords of tissue that radiate from the point of attachment and terminate on the inner surface of the wall. With the exception of these cords and a certain amount of loose tissue hanging to them, the fully grown distortion is quite empty, contrasting with the form of E. Vaccinii on *Rhododendron viscosum* commonly known as E. Azaleæ. In the young condition the distortions of E. Andromedæ are solid and almost succulent like those of the other form referred to.

The cords which traverse the interior of the gall are nothing more than the distorted vascular bundles to which hangs a certain amount of loose parenchymatous tissue. The cells of the latter are very much elongated and very thin walled. Sometimes they even branch (fig. 12), forming a mesh work of filaments, often of considerable extent. In the younger distortions this parenchymatous tissue is more solid, and it may be said indeed to represent the distorted leaf parenchyma, but, as the gall increases in size, the cells are torn apart and, ceasing to multiply, leave the interior of the distortion hollow. As far as the vascular bundles are concerned, while they are very much split up and twisted, the spiral ducts and other wood elements individually present no very abnormal appearance.

The wall, which in the mature specimens is really nearly all there is to the distortion, consists of a number of layers of rounded parenchyma cells, tightly packed near the surface and gradually merging into the elongated cells below (fig. 1). The epidermal cells themselves, while enormously increased in number, retain their normal size, but the others are considerably enlarged. It is to the excessively rapid growth of the cells on the periphery and almost entire quiescence of those in the interior that the hollow character of the gall is due.

The hyphæ of the parasite are mainly located in the wall of the distortion but some are seen among the parenchyma cells which cling around the vascular bundles. They are very fine, not more than 1.5μ in diameter, and are much branched, but never seem actually to enter the cells. The basidia which arise from them push their way up in the usual fashion between the cells of the epidermis. They arise as outgrowths directly from the hyphæ, with which their connection may be easily demonstrated (figs. 7, 8, 9). In each basidium a well defined nucleus is seen and its division and the subsequent formation of the spores were not seen to differ at all from that described by Rosen[2] in other Basidiomycetes. For further details one should consult this article and also the papers by Wager.[3] Of the general course of the formation of the spores Woronin has given a description, which corresponds to the figures here shown (figs. 2–6). As in other Exobasidia the number of spores on a single basidium is not constant, varying usually from four to seven, while in rare cases two were observed.

As far as the writer has seen the spores do not differ materially from those of Exobasidium Vaccinii and are subject to as much variation. They have the same elongate, sometimes slightly curved shape and finely granular contents. The size as measured in the specimens examined is scarcely more than that of the spores of E. Vaccinii, being about 14–15μ long by 3μ wide. This does not correspond, it is true, to the published descriptions, which give the size as 22–25μ long. That the spores measured were mature there can be no doubt, for many of them had become divided after the manner of the ripe spores of Exobasidia. In the specimens of Exobasidium Andromedæ in Ellis[4] the longest spore obtained was 18μ but the majority were of the size already given.

In this connection attention may be called to a misprint in Saccardo's Sylloge Fungorum[5] and in Winter's Pilze[6] where

[2] Cohn's Beitræge **6**: 259.
[3] Annals of Botany **7**: 489. 1893.—**8**: 321. 1894.
[4] N. A. F.
[5] **6**: 664.
[6] Rabh. Krypt. Flora **1**[4]: 322.

the measurement of the spores of E. Vaccinii is given as 5–8μ. On turning to Woronin's paper,[7] to which both of these descriptions are referred, it is seen that the measurement given by him is 14–17 × 3μ.

Besides the basidiospores there are found certain forms of conidial fructification. The first form is like that described by other writers on Exobasidium Vaccinii and consists of small acicular spores borne on much branched hyphæ among the basidia. The conidia of the second form are larger and are borne singly on rather stout hyphæ not occurring with the basidia (fig. 11). In germinating both of these forms send out the small acicular secondary spores, like those produced in the germination of the basidiospores. The large hollow distortions are also found on other species of Andromeda. Specimens of an Exobasidium on *Andromeda floribunda* were sent me by Dr. W. C. Sturgis, collected by him in West Virginia, which resembles exactly in all respects the E. Andromedæ.

There occurs on Andromeda ligustrina another form of Exobasidium which closely resembles in general appearance the form figured by Woronin for E. Vaccinii[8] on *Vaccinium Vitis-Idaea.* A microscopical examination went further to confirm the impression of the similarity of these two forms. Figure 17 shows in a diagrammatic outline how a section of one of these distortions resembles Woronin's figures.[9] There is not a very great derangement of the leaf tissues; the palisade cells are somewhat enlarged and the parenchyma considerably thicker than is normal. The hyphæ and basidia are in no way different from those of E. Vaccinii, nor for that matter from those of E. Andromedæ. The close resemblance of this distortion to that of E. Vaccinii on one hand and the fact that it occurred on the same host as E. Andromedæ lead the writer to suspect a possible connection between these forms and cultures on living plants were undertaken to establish some certainty about this matter.

At first it was attempted to raise the spores on nutrient media and for this purpose cultures were made on agar with various substances for the nutritive base. In agar made with a decoction of young leaves of various ericaceous plants it was possible to get the spores to germinate and produce the small

[7] Verhandl. Nat. Ges. z. Freiburg **4:** —. [Heft 4.]
[8] l. c. *pl. 1. figs. 3–8.*
[9] l. c. *pl. 2. figs. 1–4.*

fusiform secondary spores, such as Woronin[10] and Brefeld[11] figure, which kept on multiplying for some time and then finally refused to grow any more. Transfers of these on live plants produced no results, so the plan was abandoned for the time being and attention was turned to making inoculations on living plants from fresh material.

For the cultures on live plants healthy young specimens of Andromeda ligustrina, Rhododendron viscosum, and Gaylussaccia resinosa entirely free from any signs of Exobasidia were selected. The experiments were carried on at Newport, R. I., during the summer of 1894, the plants having been selected the previous year so that they would be well established. During the course of the experiments the plants were kept in a glass case excluded from accidental infection and separated from each other. Beginning on the 10th of July, and for a number of days following, infections were made on these plants with the spores of various Exobasidia.

The specimens of Exobasidium used were selected with great care, only perfectly fresh ones which were as far as possible removed from contamination with other spores being collected. As soon as picked they were placed in sterilized tin boxes and so kept until the inoculation was made. As an additional safeguard specimens were not taken from one locality only, but from as wide a range of territory as possible.

The first infections were made with Exobasidium Andromedæ the surface of the distortion being scraped with a sterilized platinum spatula moistened with a drop or two of boiled water. The spores thus obtained were examined in a sterilized Van Tieghem cell and afterwards transferred to the buds and young leaves of the plants to be inoculated. In this way several plants of Andromeda, Rhododendron, and Gaylussaccia of the species already named were infected. The plants thus prepared were then isolated in a moist chamber to await developments. This treatment was repeated on other specimens.

In the same way other plants of the same kind were inoculated with spores of Exobasidium Vaccinii and also duly isolated. The experiments on Rhododendron viscosum failed for some reason or other and we will turn our attention to those on the other plants which were more successful.

[10]l. c. *pl. 3. figs. 10–13.*
[11]Untersuch. aus d. Gesammtgeb. der Myk. 8: 9. *pl. 1. figs. 17–22.*

About ten days after the inoculation of the Andromeda plants with the spores of E. Andromedæ, there were noticed on the leaves faint discolorations, at first yellowish and later turning to pink. About five days later, the spots, which had considerably enlarged, began to show unmistakable signs of thickening, forming the familiar concavities in the leaves seen in other Exobasidia. In external form, and also in the matter of basidia and spores which will be discussed later, this distortion resembled precisely the leaf form on Andromeda ligustrina which had been collected previously. This indicates the fact that the Exobasidium Andromedæ which produces the large distortions of the young buds is identical with the leaf form found later in the summer.

The transfers on Gaylussaccia from the E. Andromedæ gave no definite results, perhaps owing to a number of mishaps to which these specimens were unfortunately subjected.

The infections made from E. Vaccinii now to be spoken of were, however, especially instructive. Those on Gaylussaccia developed in the way one would expect, the distortion on the leaf being of the kind collected out of doors near the end of the season. The most critical and interesting cultures, however, were those of this species on the Andromeda. The necessity of being especially careful with these cultures being evident, the writer adopted all possible precautions to avoid contamination. As in other cases, control specimens which had not been infected were kept under precisely similar conditions, without anything appearing on them. After about the same lapse of time as in other cases there appeared on the Andromeda leaves infected with E. Vaccinii, distortions very similar to those seen on Gaylussaccia and also to the leaf form on Andromeda which has already been described. Basidia and spores were produced from the mycelium concerning which more will be said later. That this distortion, so exactly similar to the one produced by the inoculations of the leaves of Andromeda with spores of the so-called Exobasidium Andromedæ, should be also formed by the growth of undoubted Exobasidium Vaccinii on the same host is very strong evidence of the identity of the two forms.

But before proceeding further in this discussion it will be well to speak of the microscopical appearances presented by these distortions, the description of which has been purposely left until now because of their great similarity. In their general form all of these distortions resulting from the growth of artificial inoculations closely resemble the form of Exobasidium Vaccinii on Vaccinium Vitis-Idaea described by Woronin,[12] and the forms collected by the writer on the leaves of Andromeda and Gaylussaccia (figs. 17–20). Microscopically considered the character of the distortion on the Andromeda, from the infections of both the E. Andromedæ and the E. Vaccinii, is so precisely similar to that already described as collected in the field on the leaves of Andromeda that a description of them would be a mere repetition of the facts therein given. The mycelium, basidia, and spores likewise present no peculiarities which can separate them from those of E. Vaccinii. The spores measure $12–16 \times 3\mu$ and have the characteristic shape and appearance of those of the last named fungus (figs. 13–16).

Summing up the case, it is something like this. As has been shown above, aside from the form of the distortion, *Exobasidium Vaccinii* (Fuckel) Woronin and *E. Andromedæ* Peck cannot well be distinguished. The former can produce the same form of distortion on both Gaylussaccia and Andromeda and the latter has been made to produce a similar growth on Andromeda. Microscopically these forms do not differ. The natural conclusion is that these two species of Exobasidium are one and the same and the form producing large bag-like distortions on Andromeda should be considered a form of *Exobasidium Vaccinii* (Fuckel) Woronin.

It must be admitted that, at the time of writing, identity has not been completely established. To produce the typical form of E. Andromedæ with inoculations of spores of E. Vaccinii would be very desirable, but probably exceedingly difficult owing to the season of the year when the inoculations would have to be made. It ought to be perfectly easy however to grow distortions on Gaylussaccia from specimens of the so-called E. Andromedæ and it was the failure of these experiments which is most to be regretted.

The difference in size and structure of the distortions as a basis of specific distinction does not seem to have much weight. It is evident that the larger distortions are produced only in the early part of the year when the fungus attacks the young and sensitive tissue. In the forms ordinarily acknowledged to be Exobasidium Vaccinii there appears first the large distortion on Rhododendron viscosum formerly known as E. Azaleæ, and also on Gaylussaccia resinosa in the earliest

[12] l. c., p. 5. *pl. 11. figs. 1–6.*

formed distortions, whole shoots are transformed.[18] Later in the season the Exobasidium forms only slight local distortions on the leaves, and still later one finds forms which do not distort the tissues of the host plant at all, but simply form a scurf on the lower side of the leaves. The same succession is found in the forms on Andromeda down to the last mentioned, to which my attention was called by Dr. W. A. Setchell at Woods Hole, Mass., late in the month of August. It was also found up to early September in Newport, R. I. This form, which appears as simply slight whitish spots on the under side of the leaves, has not been definitely connected with the others as yet by means of cultures, but the spores and basidia are the same as those of the other forms on Andromeda.

This being the case it would appear that, in Exobasidium Vaccinii at least, the form and extent of the hypertrophy depends both on the host and the age of the tissues affected. The older tissues do not respond so readily to the stimulation of the parasite, and the result is a more local hypertrophy or none at all. Differences of these kinds may be commoner than is generally recognized, and where, in the simpler forms of fungi, the distortion plays an important part in specific distinctions only actual experiment with living cultures could determine whether two closely similar species are really distinct or not.

Cambridge, Mass.

Explanation of Plate VI.

Fig. 1. Section of wall of distortion of Exobasidium Andromedæ on Andromeda ligustrina. × 210.

Figs. 2–9. Various stages in the development of the basidia and spores of E. Andromedæ. × 550.

Fig. 10. Mature and germinating spores of same. × 550.

Fig. 11. Conidial spores of same. × 360.

Fig. 12. Distorted parenchyma cells from the center of the gall. × 210.

Figs. 13–14. Basidia and spores from infection of Andromeda leaf with E. Andromedæ. × 550.

Figs. 15–16. Basidia and spores from infection of Andromeda leaf with E. Vaccinii.

Fig. 17. Outline of distortion produced by E. Vaccinii on Andromeda leaf. × 10.

Fig. 18. Same produced by E. Andromedæ. × 10.

Fig. 19. Same collected in the field. × 10.

Fig. 20. Same of E. Vaccinii on Gaylussaccia collected in the field. × 10.

⁂ All of the figures reduced about ⅓ in reproduction. Figures 1–16 were drawn with the aid of an Abbé camera.

[18] The writer collected a form similar to this on Andromeda polifolia at Shelbourne, N. H., in June, 1894.

Contributions from the Cryptogamic Laboratory of Harvard University. XXXIII.

Development of the cystocarp of Champia parvula.

BRADLEY MOORE DAVIS.

WITH PLATES VII AND VIII.

Champia parvula (J. Ag.) Harv. is representative of a type of carposporic reproduction remarkable for the phenomenon of cell fusion which takes place previous to the formation of the glomerule of spores. This genus together with Chylocladia and Lomentaria form a group agreeing with each other, according to Hauptfleisch,[1] in the essential points of the development of the cystocarp. The steps in this process, as described by Hauptfleisch, are very interesting and, as the subject is complex, the writer thinks that he cannot better introduce the matter which treats of his own observations than by giving first a brief summary of the results obtained by the first investigator of the fruit development of these forms.

The following four paragraphs will then constitute a brief sketch of Hauptfleisch's conclusions:

(1) The procarpic branches (Carpogonäste) are found near the tips of the branches of the frond. Each procarpic branch is attached to an ordinary thallus cell and the latter is united to one of the internal filaments (Markfaden) that traverse longitudinally the interior of the hollow fronds. The procarpic branches consist of three or four cells (three in the case of Champia), the terminal one being the carpogonium and bearing a delicate trichogyne which projects through the outer wall of the frond.

(2) After or at the time of the formation of the procarpic branch there is developed an auxiliary cell (two in Chylocladia). An ordinary thallus cell, neighbor to the cell which bears the procarpic branch, becomes richer in cell-contents and then divides into an upper and a lower cell. The upper cell is the auxiliary cell.

(3) When the carpogonium is fertilized the trichogyne withers. The cells of the procarpic branch then gradually

[1] Hauptfleisch, Die Fruchtentwickelung der Gattung Chylocladia, Champia, und Lomentaria. Flora 75: 306. 1892.

fuse together, beginning at the carpogonium end and there results a large "fusion cell."

In Chylocladia and Champia the fusion of the cells of the procarpic branch extends so far that it finally includes the cell which bears the procarpic branch. The very large "fusion cell" then unites with the auxiliary cell which usually sends out a process for the purpose and this auxiliary cell becomes the "central cell" from which the glomerule of spores is developed. Slight modifications of the process as stated above are found in some species, but this is the phenomenon as described for Champia parvula and the main principle of a union between a fusion cell and an auxiliary cell is true in all cases. Hauptfleisch states that in *Chylocladia kaliformis* the fusion cell contains one large nucleus resulting from the union of all the nuclei in the cells of the procarpic branch. The auxiliary cell also contains a single nucleus and when the fusion cell unites with it the two nuclei approach each other and coalesce.

In Champia parvula the hook-shaped process from the fusion cell, that is put out towards the auxiliary cell, contains a single large nucleus.

(4) The wall of the cystocarp is formed in the same manner in all the genera.

Filaments spring from the cells neighboring those concerned in the process of fertilization and spore formation, and by their growth and branching the wall of the cystocarp is formed. The interior of the young cystocarp is more or less filled with a loose network of filaments that are pushed against the side of the sporangium wall by the development of the glomerule of spores.

The material with which the writer worked was collected at Woods Hole, Mass., during the summer of 1894. The observations were made chiefly from sections, as it was not easy to crush out preparations, particularly of older stages of the fruit. If care be taken the tissues of the plant may be imbedded in paraffin and sectioned without material shrinkage of the cells, such serial sections being very desirable for the study of certain stages. The writer also employed a method of sectioning suggested by Mr. W. J. V. Osterhout, in which the tissues were frozen in a solution of gum arabic. Such sections were mounted in glycerin, the method proving satisfactory and a time-saver. The specimens for the most part were stained *in toto* with Mayer's acid haemalum.

A number of antheridial plants were found during the summer, and in one instance the same plant bore both antheridial and cystocarpic branches. The antheridia form patches on the frond, indefinite in extent and variable in position, sometimes appearing as caps at the ends of the branches but more often as bands around older portions of the frond (fig. 1). The structure of the antheridium is somewhat similar to that of the genus Lomentaria described by Mr. Webber.[2] The very small antherozoids are borne singly on the tips of short filaments, which arise in branching clusters from the thallus cells. Fig. 2 shows three of these clusters and there it may be seen that each cluster consists of several short filaments, the younger being branches from the older.

We must refer at the outset to an interesting point in the structure of the older cells of the frond. The young cells at the apex of a branch contain only one nucleus but cells somewhat removed from the growing point are multinucleate. This character is very striking and is shown in most of the figures (see figs. 2, 7, 9, 14, etc.).

The writer has observed similar conditions in the older cells of several genera of Florideæ, for example Callithamnion, Griffithsia, Spermothamnion, and Polysiphonia, and in some cases, as in the older cells of Griffithsia, the number of nuclei becomes very large indeed. Apparently a multinucleate structure of the older cells of Florideæ is likely to prove a very general fact.

My preparations have shown that the procarpic branch may consist of two or three cells. It is a small structure (figs. 3 and 4), and is always attached to one of the large thallus cells. As a rule the thallus cell (*t*, in the figures) is joined to one of the internal filaments, *f*, that traverse the frond, but this is not always the case, and procarps and young cystocarps have been found quite removed from it.

The trichogyne is a very delicate structure arising from an extremely small cell, the carpogonium, *c*. The whole structure is so small that even under such high magnification as 1,500 diameters, it is very difficult to determine the structure of its cell contents. There is granular matter in the carpogonium (fig. 4) that stains rather deeply and may be nuclear substance.

In one case (fig. 3) a trichogyne was found with what ap-

[2] Webber. On the antheridia of Lomentaria. Ann. of Bot. **5**: 226. 1891.

peared to be an antherozoid at its tip, but the trichogyne was so very delicate and the antherozoid so small that the relation between the two structures could not be satisfactorily studied. Even if such stages as are shown in fig. 3 were common their small size seems to the writer to preclude the possibility of determining what takes place at the time the antherozoid is applied to the trichogyne.

The single cell or each of the two cells of the procarpic branch below the carpogonium contains a single well defined nucleus. The thallus cell (fig. 3 and 4, *t*) to which the procarpic branch is attached is larger and contains rather denser cell-contents than the neighboring cells of the frond, but like them is multinucleate. It is probably always united to neighboring thallus cells by strands of protoplasm, although such connections may not always appear in sections which are necessarily cut in a single plane. The attachment to the internal filament is usually by a broad strand of protoplasm, and not infrequently one of the bulb cells found along the internal filaments occurs opposite this point (fig. 3, *b*).

The trichogyne withers quickly and the upper portion disappears very rapidly. The swollen portion at the base (carpogonium) remains somewhat longer (figs. 5 and 6) but takes the stain very faintly and finally disappears, and the lower cells of the procarpic branch are left attached to the thallus cell. The condition of the procarp is then either that shown in fig. 7 or fig. 8; that is, it consists of one or two cells, each probably containing as a rule only a single nucleus, attached to a thallus cell which is multinucleate. At this time the protoplasm of the thallus cell and of the cells of the procarpic branch above has become very dense and stains heavily, so that these stages appear very conspicuous in the sections. The nuclei in the thallus cell multiply in number and increase in size at this period when the cell is becoming gorged with protoplasm.

At this point we had best consider the changes which take place in the tissue around the cells of the procarp after the trichogyne has disappeared. The contents of the thallus cells directly around that which bears the procarpic branch gradually assume a different character. The protoplasm becomes very much denser and the nuclei increase in number and grow larger in diameter. These thallus cells are evidently what Hauptfleisch has called the auxiliary cells. There are frequently several of them but there may be only one. They are exactly similar to the thallus cell, bearing the procarpic branch, in the appearance of their cell contents, and we can only identify the latter by its attachment to the procarpic branch on the outside and as a rule to an internal filament on the inside of the frond.

Coincident with the gradual change in the character of the cell-contents which precedes the differentiation of the auxiliary cells, a number of short filaments begin to grow up over the procarpic branch. The filaments arise from the thallus cells around the procarpic branch, meeting at a point above it, and form a sort of dome over that structure. This is the beginning of the wall of the cystocarp. In the early stages it is perfectly evident that these filaments arise from ordinary thallus cells which afterward become auxiliary cells. So the auxiliary cells are not special structures developed separately from the vegetative tissue, but they are cells of the vegetative tissue directly around the procarp that become modified as to their cell-contents in a manner quite similar to those of the procarp.

An examination of the figures will perhaps serve to make the points considered in the last two paragraphs more plain. In several of the figures previously described (figs. 5, 6, 7, and 8) it will be noticed that the thallus cells on each side of the procarp have given rise to small cells above which bend over towards the procarpic branch. These with other cells, which are developed later, become the apical cells of a complex system of branches that form the wall of the cystocarp.

Fig. 9 is of a stage not very different from fig. 7. Here the wall of the cystocarp has begun to develop, but the conditions of the procarpic cell, *p*, and the thallus cell which bears it, *t*, are not materially changed except that they are larger and their nuclei much more prominent. On the right hand side of the figure is an auxiliary cell, *a*, very similar in appearance and structure to the thallus cell which bears the remains of the procarpic branch. Above the auxiliary cell is another cell rather dense in contents which is probably about to change into an auxiliary cell.

Fig. 10 illustrates a case in which the procarpic branch was originally composed of two cells besides the carpogonium and trichogyne. The thallus cell, *t*, which bears the procarpic branch is so cut that only a portion appears in this section.

Above it are the cells of the procarpic branch and on the left are three auxiliary cells, two at the side and one somewhat behind the others. The figure is especially interesting because it is evident that the vegetative branch, *v*, is directly continued from the two auxiliary cells at the side.

Figs. 9 and 10 do not give a correct idea of the great increase in size of the auxiliary cells and the cells of the procarp at this stage of development, for the magnification is much less than in figs. 6 and 7.

The writer has never observed any evidence that the cells of the procarpic branch ever fuse with each other or with the thallus cell which bears them. After the withering of the trichogyne the cells increase in size and the strands of protoplasm connecting them become much wider, but the cell-outlines remain quite distinct and the nuclei entirely separate. There is no union of nuclei into one large fusion nucleus. The thallus cell bearing the procarpic branch continues in its multinucleate condition. Each cell of the procarpic branch contains one nucleus which may afterwards fragment into several.

The auxiliary cells always contain in the beginning a number of nuclei and in the writer's preparations nothing was ever observed that would indicate a later union into one fusion nucleus; they always remain multinucleate.

However, some very interesting cytoplasmic disturbances take place. The thallus cell bearing the procarpic branch sends out many protoplasmic processes that unite with the auxiliary cells directly adjoining it, sometimes two or three processes with the same cell. In a like manner the auxiliary cells unite with one another and with the vegetative cells around them. This cytoplasmic activity occurs while the cystocarp is developing, but the position and number of the nuclei in the cells are apparently not affected by the formation of this net-work of fused cells. Fig. 11 illustrates an instance where the thallus cell, *t*, is connected by two strands of protoplasm with the auxiliary cell, *a*, and a similar condition is shown on the left hand side of fig. 13. In fig. 13 the reader will also observe how general is the cytoplasmic union of cells in the loose tissue around the young cystocarp. It should also be noted that the cytoplasmic fusion processes are smaller than the nuclei in the cells directly concerned with the development of the cystocarp.

The development of the favellæ of spores now remains to be considered. We must start with stages such as are shown in figs. 9 and 10. It will be remembered that at this stage the trichogyne and carpogonium have entirely disappeared so that the cell lettered *p* in these two figures is the one directly under the carpogonium. This cell gives rise to the cystocarp. By several transverse divisions, which are usually somewhat oblique, it forms a short branch consisting of four or five cells, two stages of which will be seen in figs. 11 and 12. The branch is greatly bent to one side in later stages and then oblique walls are formed across the upper segments in a very irregular manner, and there results a compact mass of cells divided up into a number of lobes. The entire young cystocarp is really a very complex set of filaments consisting of angular and irregularly shaped cells, but this structure is not readily shown in sections. The cells at first contain each a single nucleus, but when the cystocarp is mature it is apparent that the spores are borne on the ends of short branches (fig. 14) whose cells are multinucleate although each spore is uninucleate.

As the cystocarp arises from the cell of the procarpic branch just below the carpogonium, this is the place where we should expect to find cross fusion with auxiliary cells if such exists. The writer has observed no specimens which would indicate that an auxiliary cell ever completely fused with any of the cells directly concerned with the development of the cystocarp. Nothing was ever seen that could be compared with the "central cell" of Hauptfleisch. It is true that auxiliary cells are clustered around the cells of the young cystocarp, and it would be very easy for them to unite by protoplasmic processes, but the writer saw no clear evidence of such cytoplasmic fusion, much less of any nuclear disturbances. In some cases the cells of young cystocarps have been quite removed from auxiliary cells (fig. 14) and it was quite evident that no fusion had taken place; but when such cells are close together the protoplasm is frequently brought into such close proximity as to make it very difficult to decide the question of cytoplasmic fusion.

What is the cause of the very general cytoplasmic union of the cells at the base of the cystocarp? The phenomenon begins after the trichogyne has disappeared and the procarp has presumably been fertilized. It is concerned with the thallus cell which bears the procarpic branch and the auxiliary cells. In all these cells the protoplasm becomes very much denser and the nuclei increase greatly in size in marked contrast to the ordinary vegetative cells of the thallus. The nuclei do not fuse. It has been suggested by several investigators that cytoplasmic activity of this nature is for nutritive purposes and the writer is inclined to believe this to be true of Champia.

The auxiliary cells are then cells in the neighborhood of the procarpic branch whose protoplasm has changed in character in a similar manner to the cell contents of the latter structure. They are not specially developed organs of the frond but are at first ordinary vegetative cells at the base of the filaments that later form the wall of the cystocarp. They vary in number and they vary in the degree in which their cell contents have been modified.

How is the procarp fertilized? Unfortunately the small size of the trichogynes and antherozoids presents a very serious obstacle to the study of this point. The conditions are further complicated by the poorly defined character of the nucleus in the diminutive carpogonium and because the trichogyne withers very early and completely disappears together with the carpogonium. To explain the facts according to present accepted views of the nature of the sexual act it must be supposed that the fertilizing substance, presumably nuclear matter, passes through the trichogyne and carpogonium into the cell below. Such complexity of conditions is quite unusual for the sexual act and presents great difficulties to a clear understanding of the subject and these difficulties are made more emphatic by the insignificant appearance of the trichogynes. The trichogynes resemble somewhat degenerate cells, quite lacking the clear well defined cell structure which we usually expect of sexual elements.

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Explanation of Plates VII and VIII.

Preparations stained with Mayer's acid haemalum. All figures sketched with Abbé camera and lettered as follows: *a*, auxiliary cell; *b*, bulb cell; *c*, carpogonium; *f*, internal filament; *p*, cell of procarp just below carpogonium; *t*, thallus cell bearing procarp; *v*, developing wall of cystocarp; *x*, antherozoid. Figure 1 magnified about 5 diameters; figures 2–8 about 730 diameters; figures 9–13 about 530 diameters; figure 14 about 260 diameters.

Plate VII.

Fig. 1. Portion of frond showing distribution of antheridia.

Fig. 2. Section of frond with antheridial filaments arising from the thallus cells; *x*, antherozoids.

Fig. 3. An adult procarp attached to an internal filament; *x*, antherozoid.

Fig. 4. A procarp showing granular matter, which may possibly be a nucleus, at base of carpogonium.

Fig. 5. Procarp with withered trichogyne; two cells between carpogonium and thallus cell.

Fig. 6. Procarp with withered trichogyne, one cell between carpogonium and thallus cell.

Fig. 7. Trichogyne and carpogonium entirely gone, one cell of procarp, *p*, above the thallus cell, *t*.

Fig. 8. Trichogyne and carpogonium entirely gone, two cells of procarp above the thallus cell.

Plate VIII.

Fig. 9. Procarp with one cell above the thallus cell; auxiliary cell at the right; wall of cystocarp beginning to develop.

Fig. 10. Procarp with two cells above the thallus cell; auxiliary cells at the left; wall of cystocarp developing.

Fig. 11. Young cystocarp.

Fig. 12. Young cystocarp, next stage to figure 11.

Fig. 13. Half matured cystocarp.

Fig. 14. Group of ripe spores.

Notes on the flora of Chicago and vicinity. II.[1]

E. J. HILL.

CEANOTHUS OVATUS Desf.—This has recently been found in two localities near the shore of Lake Michigan, Edgemoor and Wilsons, Lake co., Ind. The nearest place where it is recorded as occurring elsewhere is in Winnebago co., Ill., or not far from Beloit, Wis. Three or four localities in the northern part of the southern peninsula of Michigan are mentioned, and according to the recent Catalogue of Ohio Plants by Kellerman and Werner it is found, though rarely, in the northern part of Ohio. Its distribution in the lake region is therefore peculiar, since the stations in Indiana are isolated, and distant from those of Illinois, Michigan and Ohio.

THASPIUM PINNATIFIDUM Gray.—I came across this plant in 1870 growing by the banks of the Kankakee river near Waldron, Kankakee co., Ill. It was at the time confused with *T. barbinode*, a specimen of the former being taken in flower and placed in my collection with one of the latter in fruit, as both grew in the locality. When more carefully examined some years afterward the two did not accord very well in appearance, but the lack of fruit and removal from the neighborhood did not permit a definite determination. In the summer of 1894 I found a Thaspium at Momence, Ill., whose fruit differed from that of T. barbinode. It was taken from the bank of the Kankakee, about ten miles above the former locality. Another fruiting specimen was obtained from Momence the past season. They have the characteristic fruit of T. pinnatifidum, all the ribs being winged, three of them being narrow. The leaves are somewhat intermediate between those of this species and T. barbinode. The leaflets are, however, usually much smaller and differently cut and divided into oval or oblong segments. T. pinnatifidum has hitherto been given as a plant of the barrens and mountains of Kentucky, Tennessee and North Carolina. Careful inspection of plants may locate it in places between the Kankakee river and this southern range, and forms may be found which will closely connect the two.

ARENARIA PATULA Michx.—This little sandwort has in part

[1] For the first paper see BOT. GAZ. 17: 246. Ag. 1892.

a similar distribution and history. Originally described by Michaux with a habitat "in rupibus circa *Knoxville*,"[2] it was afterwards discovered in Kentucky by Dr. Short, and in the mountains of Virginia by Prof. Ruffner, and traced to Arkansas and Texas by Nuttall, Dr. Pitcher, Drummond and others (as *A. Pitcheri*). About 1870 Prof. H. H. Babcock detected it on the limestone formations of the Des Plaines river at Riverside just west of Chicago.[3] It occurs in considerable abundance in some localities of limestone within the city limits near Windsor Park and on Stony Island, and also beyond them at Lamont on the Des Plaines. It is reported from one locality, Tippecanoe co., Ind.,[4] between these stations in Illinois and its southern range.

THASPIUM BARBINODE Nutt.—This quite often has puberulent fruit, so much so that the figures of the fruit given in Coulter and Rose's "Notes on the Umbelliferæ of the United States,"[5] though true as to the wings, do not cover these cases. This is specially the case with plants on the opposite shore of Lake Michigan at Benton Harbor, Mich. In these the intervals of the ribs are strongly puberulent with short, blunt hairs, much as in T. pinnatifidum.

ECHINACEA ANGUSTIFOLIA DC.—Found on a small prairie east of Durham, a station on the L. S. & M. S. R. R., in Laporte co., Ind. As but a few plants were seen beside the road-bed it may possibly be an introduced plant, though more probably native, as such survivals are found in railway enclosures within cultivated districts. The range of the species is rather from Wisconsin and Illinois west and south, but it has been found as far east as Keweenaw co., Mich., about the same distance east as this station in Indiana. The farthest east I had previously seen it was on prairies east of Kankakee, Ill.

HELIANTHUS ANNUUS L.—The introduced plant native at the west was reported in my previous article as growing in the dump from stock trains west of the city in 1891. The following year it had appeared as a weed under the same conditions of growth along railroads east of the city at Roby, Ind., and is now well established in this locality by the shores of Lake Michigan.

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[2] Flora Bor. Amer. 1: 273. 1803.
[3] Flora of Chicago and vicinity. The Lens 1: 23. 1872.
[4] Catalogue of the plants of Indiana by the Editors of the BOT. GAZ. 1881.
[5] BOT. GAZ. 12: 136. *pl. 5. figs. 59, 60.* Je. 1887.

MYOSOTIS LAXA Lehm.—The range of this plant is given in the last edition of Gray's Manual as "Newf. to N. Y." Specimens of a Myosotis sent for identification some years ago from Painesville, Ohio, led me to expect its presence there, and the recent Catalogue of Ohio Plants by Kellerman and Werner mentions it as "frequent in marshes and wet places in northern Ohio."[6] Last summer I found it in abundance in the wet ground bordering the Calumet river near Dune Park, Porter co., Ind. The discovery of this plant in a region that had been quite well explored botanically might indicate that it is an introduction. If a recent comer it had better be considered an escape from gardens, being cultivated for *M. palustris*, of which it has been made a variety by some. Residents to whom the plant was shown called it Forget-me-not. But it is more probably a native that had been overlooked, like some others mentioned in this article. I have found it in the St. Lawrence basin by the Saguenay river, and its range in Canada is given by Macoun as from the lower St. Lawrence to the vicinity of Buffalo, N. Y., so that its connection with the eastern flora is not difficult to make out. There is still much to learn about the details of the geographical distribution of some of the less common plants, and apparent gaps may yet be filled.

CELTIS OCCIDENTALIS L. var. PUMILA Gray.—In 1893 a couple of small hackberries were found near Millers, Ind. They were nearly out of flower (June 6), but were identified as above. They grew near the shore of Lake Michigan, and being but three or four feet high they could not again be found in the wilderness of shrubs and shrubby oaks which characterized this section of the dune region. Last year I came across several more about two miles from the former place, and in a locality not so difficult to keep in mind. This was along the Grand Calumet and near its mouth now silted up with sand. Some of them were large examples of the shrub, the largest stems three inches in diameter, and fifteen feet long. Several ascending stems usually spring from the same root and form clumps about as broad as high. They are very scraggy, the branches thickly set with short, stiff, sub-spinous twigs two or three inches long. They are caused by the winter-killing of the tips, so that the bush, especially when stripped of leaves, resembles a thorn-bush. The habit is so unlike that of the common hackberry, a tree not infre-

[6] Geology of Ohio 7^2: 112. [Botany.]

quent in some sections about Chicago, that it is hardly recognized as of the same species. The pointed leaves are usually narrower than in the arboreous hackberry, from narrow ovate to ovate-lanceolate, many of them falcate. Occasionally they are broad and short, both forms occurring on the same stem. The upper third or half of the leaf may be sharply serrate, especially when the leaves are young, but they are often nearly entire, or with a few callous tipped teeth mainly on one margin near the apex. The mature leaves are rather thick and firm in texture. The fruit is globose or a little prolate, one-fourth to one-third of an inch in diameter. When ripe it is of a dark brownish purple color. The flesh is orange colored as well as the stone and seed. There are some features in which it resembles *C. Mississippiensis* Bosc, as in the size of the fruit. This variety of the hackberry is a south Atlantic species, ranging westward, according to Sargent's Silva of North America **7:** 69, to Missouri, Colorado, Utah and Nevada, and growing on the rocky banks of streams. Here it occurs in the sand of the dune region, near the shores of the lake. I have traced it for a distance of three miles.

ALNUS GLUTINOSA Willd.—This is used in some parts of the city as a shade tree, and has become naturalized in some places south of Jackson Park. It has spread into the wet land, making thickets of low trees and bushes like the common alders. They fruit when at the height of four to six feet.

POTAMOGETON DIVERSIFOLIUS Raf. (*P. hybridus* Michx). —The point nearest the city where I have seen this is Laporte, Ind., where plants grow in shallow pools by the borders of Pine Lake.

P. INTERRUPTUS Kitaibel. Two localities are given for this pondweed in Morong's Naiadaceæ of North America:[7] Manistee, Mich., and the Channel islands, St. Mary's river, Mich. I first came across this plant at Manistee in 1880, near the mouth of the Little Manistee. In 1881 I found it at the latter place. These were mentioned in a contribution to the BOTANICAL GAZETTE in 1881.[8] Later in the same year it was found in the Calumet river at South Chicago. In Higley and Raddin's Flora of Cook county, Ill., and a part of Lake county, Ind.,[9] this is mentioned as a broad leaved form

[7] Mem. of Torr. Bot. Club, **3:** 54. 1893.
[8] l. c. **6:** 262. 1881.
[9] Bull. of Chicago Acad. of Sci., **2:** 124. 1891.

of *P. pectinatus* but is made identical with those from Michigan, which Dr. Morong subsequently published as *P. interruptus*. Its strong resemblance to *P. flabellatus* Babington, which Dr. Morong makes a synonym of this species, was quite apparent from the first. These three localities seem to be the only undoubted ones from which it has been obtained, though from specimens collected in the Au Sable river, Frankfort, Mich., it may also be present there. The lack of mature fruit, which I have never been able to obtain, leads to considerable difficulty in distinguishing it from forms of P. pectinatus. The locality at South Chicago was, soon after its detection there, destroyed by dredging and the building of docks, and with it the hope of getting ripe fruit late in the season near at home. I have examined them as late as the twenty-second of October without finding it. The species is no doubt extant in other localities, especially in northern Michigan.

ELEOCHARIS MELANOCARPA Torr.—Found in 1894 on the sandy borders of Pine lake, Laporte, Ind. Soon after it was detected at Dune Park, where it is quite frequent. It has been considered a maritime plant, its range being near the sea from Plymouth, Mass., to Florida. At Dune Park it grows in the sand bordering sloughs.

SCIRPUS TORREYI Olney.—This was noticed at the same time in sloughs at Dune Park, but is rare. It has not before been reported in Indiana, nor do I know of its presence in Illinois. It is so nearly like *S. pungens* in outward appearance as to be easily overlooked, but in pulling a plant from the wet soil one readily sees the difference.

HOMALOCENCHRUS LENTICULARIS Scribn. (*Leersia lenticularis* Michx.).—South bank of Kankakee river, Kankakee, Starke co., Ind. I do not find it reported elsewhere from Indiana. The locality is but a little north of its northern range in Illinois, Henderson and Peoria counties (Patterson), and is doubtless near its northern limit in Indiana.

EQUISETUM ROBUSTUM Braun.—Bluffs of St. Joseph river, near St. Joseph, Mich. Specimens of this scouring rush were obtained in 1894 growing in the springy soil of the steep banks of the river at a place locally known as Royalton Heights. This is farther north than I find it given elsewhere. In Illinois it occurs from Peoria southward. Its more usual home is toward the Ohio river.

Chicago, Ill.

The embryo-sac of Alisma Plantago.[1]

JOHN H. SCHAFFNER.

WITH PLATES IX AND X.

The embryo-sac of angiosperms still presents an inviting field for research. There seem to be many variations in the general processes which occur in it, and most of the observations on the finer structure need confirmation. Especially in regard to the real meaning of the conjugation of the polar nuclei, and what is represented by the antipodal cells, does there still seem to be much obscurity. It was for the purpose of making a preliminary study with a view for further investigation later, that the following work on the embryo-sac of Alisma was undertaken.

The embryo-sac of *Butomus umbellatus* L. was described by Vesque[2] in 1878, and later by H. Marshall Ward,[3] who also made a few observations on *Alisma Plantago* L., which agreed in general with those on Butomus. The development of the embryo of Alisma has become well known through the investigations of Hanstein.[4] Guignard[5] studied the minute processes which occur in the embryo-sac of Lilium Martagon and described the conjugation of the centrospheres of the sperm nucleus and oosphere. He observed the same process during the union of the two polar nuclei. These observations have hitherto not been confirmed.

My material was collected on July 30, 1895, and killed in a chrom-acetic acid solution: acetic acid 0.7 per cent., chromic acid 0.3 per cent., water 99 per cent. All the sections were made by imbedding in paraffin and staining on the slide. The principal stains used were anilin-safranin and acid fuchsin. The work was carried on under the direction of Professor

[1] Contribution from the Botanical Laboratory of the University of Michigan.

[2] Développement du sac embryonnaire des phanérogames angiospermes. Ann. des Sci. Nat. Bot. VI. **6**: 237–285. 1878.

[3] Contributions to our knowledge of the embryo-sac in angiosperms. Jour. Linn. Soc. Bot. **17**: 519–546. 1880.

[4] Die Entwicklung des Keimes der Monokotylen und Dikotylen. Botanische Abhandlungen aus dem Gebiet der Morphologie und Physiologie **1**: —. 1870. [Bonn.]

[5] Nouvelles Etudes sur la fécondation, etc. Ann. des Sci. Nat. Bot. VII. **14**: 163–296. 1891.

F. C. Newcombe, to whom I here express my sincere thanks for kind assistance rendered in various ways.

Development of the embryo-sac.

The young ovaries arise as protuberances around the edge of the flattened receptacle, and soon there appears in the interior of each one a schizogenetic cleft on the inner side of which the nucellus is formed. This cleft increases in size quite rapidly by enlargement and division of the cells of its walls, thus making room for the developing nucellus. When the nucellus has obtained some considerable size, there can be seen in it a large hypodermal cell which appears to be the archesporium. No division of this cell into two was observed, but at a later stage the large macrospore shows the remains of a former cell at its micropylar end (fig 1.) which is the tapetal cell. The ovule soon becomes anatropous. The integuments are two in number, but on the side of the funiculus the outer one is generally not developed. As the embryo-sac increases in size the ordinary divisions of its nucleus take place. First it divides into two, one of the daughter nuclei passing to the upper and the other to the lower end of the sac, after which each of these, by two successive divisions, produces four nuclei, thus making the typical eight-celled embryo-sac (fig. 2). Often only two nuclei could be distinguished at the base of the embryo-sac. But as it is quite narrow at this end the missing ones may have been in the adjacent sections, and there indistinguishable from the nuclei of the surrounding tissue.

All the nuclei except the three antipodal nuclei are comparatively large in size and each one contains usually one large nucleolus, but sometimes two (fig. 2). The two synergidæ lie side by side. They are surrounded by granular cell walls, and their nuclei are either spherical or ellipsoidal. They stretch across the entire upper end of the sac, and just beneath them the oosphere is suspended in a dense mass of cytoplasm. Its nucleus is usually ellipsoidal in shape. Beyond the oosphere and lying free in the cytoplasm is the upper polar nucleus. Its centrospheres usually lie on the under side, though in a few cases they were on the side toward the oosphere. The cells in the antipodal region simulate the arrangement in the egg-apparatus. There are two small nuclei lying at the base; and beyond them is the third antipodal nucleus. This nucleus always stains a very dense red with anilin-safranin and its centrospheres are usually very prominent. It would by its peculiar appearance suggest that it may be the homologue of the oosphere. These three nuclei are not surrounded by any definite cell-walls, but the cytoplasm in which they are imbedded is rather dense. Immediately beyond the antipodal cells is the lower polar nucleus. This is much the largest nucleus in the antipodal region, and it contains usually one large nucleolus. Its centrospheres lie on the upper side, toward the upper polar nucleus.

Conjugation of the polar nuclei and their centrospheres.

The two small granules lying on one side of the resting nucleus are now generally called controspheres by English writers, and this term is here employed as the most appropriate. The dense centre is appropriately designated by the usual term "centrosome," while "attraction-sphere" will be used for the hyaline layer surrounding this.

I might here state that all my observations on these bodies made heretofore[6] have been more fully confirmed during the present investigation. The centrosphere is composed of a dense central body, which appears to have a granular structure, and an outer hyaline layer, composed of a highly refractive substance, which takes little or no stain, but under favorable circumstances shows a delicate radiate structure. The whole structure is limited from the surrounding cytoplasm by a definite granular layer, which is easily distinguished and may appropriately be called a membrane. The centrospheres in the embryo-sac are much more prominent than in the surrounding tissues, and in this respect they agree with the nuclei.

As stated above, when the two polar nuclei begin to travel toward each other, they have their centrospheres so situated that they precede the nuclei; however, in a few cases, at the very beginning they were seen on the opposite side. In my preparations I was able to find all stages of the conjugation of the polar nuclei, until their complete union to form the nucleus of the embryo-sac, or definitive nucleus (figs. 3, 4, 5, 6). My observations agree in general with those of Guignard on the conjugation of the polar nuclei in Lilium Martagon.

[6] The nature and distribution of attraction-spheres and centrosomes in vegetable cells. BOT. GAZ., **19**: 445–459. 1894.

Of the two conjugating nuclei, the one from the upper end of the sac is nearly always the larger. When the two nuclei approach each other, the centrospheres join two and two, and the two couples then separate so as to permit the two nuclei to come in contact (fig. 3). While the two nuclei are fusing, the attraction-spheres gradually unite and in them can be distinguished the two controsomes lying very close together (figs. 4, 5, 6). When the two nuclei have nearly fused, the centrosomes are in contact and are also uniting (fig. 6). The fusion of the two nuclei takes place by a gradual interchange of their contents. The chromatin does not seem to unite as definite chromosomes, but there appears to be a gradual intermingling of the individual particles from which a new chromatin network is built up. The nucleoli of the two nuclei appear distinct even to an advanced stage of the conjugation, but later there appears but one, in most cases, in the definitive nucleus, showing that there has been a union of the material of the two nucleoli, or the formation of a new one from nucleolar matter derived from the old ones (fig. 7). But the intermediate processes were not observed.

The endosperm is not very abundant when the embryo is completely developed. It appears to be formed entirely from the definitive nucleus. The first division of this nucleus generally precedes the first division of the oospore (fig. 19). These nuclei continue to divide and spread out through the embryo-sac as it increases in size. In one case I observed four endosperm cells at the time when the first division of the oospore was in the close daughter-skein stage (fig. 8).

Phenomena of fertilization.

The young pollen grain has two nuclei, a large one, which never stains very dark with anilin-safranin, and a smaller one which takes an intense dark red stain (fig. 9). Subsequently this small nucleus divides again (figs. 10, 11, 12), thus leaving the mature grain with one large nucleus and two small ones. These small nuclei always stain a very intensive red with anilin-safranin. When the pollen grain falls on the stigma and germinates, its tube passes through the style and thence down through the tissue on the inner side of the ovary. At the base of this the tissue is so arranged that the tube readily finds its way toward the base of the funiculus, where it comes into the free cavity of the ovary. Here it is generally much contorted before reaching the micropyle, through the middle of which it finally passes to the top of the embryo-sac. Just before the entrance of the pollen tube into the micropyle, the two synergidæ, as stated before, lie at the summit of the embryo-sac, with the oosphere suspended below. The tube in passing through the micropyle is considerably constricted, but when it reaches the embryo-sac it increases appreciably in diameter (fig. 14). On reaching the apex of the sac, the pollen-tube does not grow directly toward the oosphere, but always passes down on one side near the wall of the embryo-sac encountering the nucleus of one of the synergidæ on its passage, which disappears at this time. The tube passes by the nucleus and seems to be nourished by its contents. At a certain stage the outline of the nucleus and its nucleolus can still be distinguished, but it takes little or no stain (fig. 15).

The nucleus of the other synergida persists for a long time, at least until the proembryo is composed of several cells. The pollen-tube after entering the embryo-sac takes a very dark-red stain and in it can be distinguished two small nuclei, which stain exactly like those in the mature pollen-grain. The deep red staining of the tube is perhaps due to the nourishment which it receives from the disintegrating synergida. The upper nucleus of the pollen-tube always appears spindle-shaped or much elongated (figs. 7, 13, 14, 16). The lower one is more spherical and is preceded by two centrospheres (figs. 7, 13, 16). These centrospheres are usually very distinct, because of the clear color of the attraction-spheres in contrast to the dark red stain of the surrounding material. The upper nucleus remains in the tube after fertilization is accomplished (figs. 18, 19). The pollen-tube usually curves toward the oosphere before the sperm nucleus leaves it (fig. 17).

In the meantime changes are taking place in the oosphere. The centrospheres lie on the side toward the sperm nucleus (figs. 13, 16, 17). They also appear to travel toward the sperm nucleus, since at this stage they are farther from the nucleus than usually (figs. 13, 17). The nucleus of the oosphere is no longer symmetrical in outline as in the earlier stages, but is drawn out on the side toward its centrospheres into a considerable bulge (figs. 13, 16, 17). Thus it will be seen that all the preliminary stages in the approach of the two sexual nuclei indicate a conjugation of the centrospheres, or what has been called a "quadrille of the centres."

I made hundreds of sections in the vain attempt to follow out the stages of conjugation of the male and female pronuclei, but my material proved to be very unfavorable. I succeeded in finding but one instance of actual conjugation (fig. 18). In this section the sperm nucleus had left the pollen-tube and was in contact with the egg nucleus. No centrospheres were seen. They were very likely lying just above and beneath the line of contact and were thus invisible. However, the positions of the four centrospheres immediately before conjugation indicate the same kind of action as was observed for the two polar nuclei.

Recently, several American zoologists have attempted to investigate the phenomena connected with the conjugation of the male and female pronuclei. Wheeler,[7] in studying the fertilized egg of *Mysostoma glabrum*, concludes that the archoplasm and centrosomes of the segmentation nucleus come entirely from the female pronucleus. He found no trace of such structures in the male pronucleus. Hence he thinks there can be no "quadrille of the centers." Wilson and Mathews[8] in their investigation on the echinoderm egg also tend to disprove the "quadrille of the centers."

Mead[9] studied maturation and fecundation in Chaetopterus pergamentaceus. He traces the archoplasm and centrosomes of the segmentation nucleus from the male pronucleus, and states that these structures disappear from the female pronucleus after the extrusion of the second polar body. Thus he can also find no "quadrille of the centers."

It appears that there is not so much contradiction in the observations as in the conclusions drawn. And it should be borne in mind that mere negative results of observation prove or disprove nothing. As Strasburger has indicated in his "Neue Untersuchungen," in regard to the invisibility of the nucleus in the ripe pollen-grain of many dicotyledons when treated with certain nuclear stains, the invisibility of the nucleus in such cases must not be interpreted as indicating the absence of a nucleus, but much rather that the methods of

[7]The behavior of the centrosomes in the fertilized egg of *Mysostoma glabrum* Leuckart. Jour. Morph. **10:** 305. 1895.

[8]Maturation, fertilization, and polarity in the echinoderm egg. New light on the quadrille of the centers. Jour. Morph. **10:** 319. 1895.

[9]Some observations on maturation and fecundation in *Chaetopterus pergamentaceus* Cuvier. Jour. Morph. **10:** 313. 1895.

preparation and staining were deficient. And subsequent developments prove the wisdom of the caution. When we compare the size of an ordinary nucleus with a centrosphere it will be seen that the suggestion in the present case becomes one of great importance.

No division of nuclei was observed in the pollen-tube. The two small nuclei in the tip of the tube, after it has entered the embryo-sac, are about the same size and take the same stain as those in the pollen-grain. These are the two sperm nuclei which come from the generative nucleus. In this case the division of the generative nucleus occurs in the pollen-grain, while more commonly it does not take place until the tube is entering the embryo-sac, as shown by Guignard and Strasburger. Strasburger has found[10] that this early division of the generative nucleus occurs in many monocotyledons, and dicotyledons. Whether the two sperm nuclei are of the same nature or whether only one of them has the power of fertilizing the oosphere, I could not determine. The appearance of the two nuclei after entering the embryo-sac would indicate that only one was a true sperm nucleus. The fate of the vegetative nucleus was not discovered, but no trace of it was seen after the pollen-tube had entered the embryo-sac.

The early development of the embryo.

It was not my intention to study the development of the embryo, but while making observations to determine the length of time that the nucleus of the remaining synergida persisted, I found that the development of the proembryo, as presented in my sections, did not agree with the statements regarding Alisma in the text books.[11] After the union of the male and female nuclei, the resulting nucleus divides in a direction at right angles to the long axis of the embryo-sac (fig. 8). The upper cell with its nucleus immediately begins to enlarge, the nucleus taking a central position (fig. 20). The lower cell increases considerably in length, the lower end becoming somewhat rounded and swollen and containing the lower nucleus. This nucleus now divides again in the same direction as the preceding division, making three nuclei for

[10] Neue Untersuchungen, etc. 8.

[11] See Goebel's Outlines of Classification and Morphology, English edition, 399. 1887; and Sachs' Text-Book of Botany, second Engl. edition, 589. 1882.

the proembryo (fig. 21). At this stage the nucleus of the one synergida still survives but it shows signs of disintegration. It disappears after this stage and its contents very likely go to nourish the enlarging nucleus of the suspensor cell. The next division is again in the lowest of the three cells, in a transverse direction (fig. 22). This gives the first four cells of the proembryo. These divisions are absolutely certain, for they were traced out through stages in which the nuclei were in the close daughter-skein, which leaves no doubt as to the origin of the different nuclei in the series. The next division which occurs is in the lowest of the four cells. This now divides in a longitudinal direction (fig. 23). The development was traced no farther. But the course described above was confirmed by numerous examples. Thus the early development of the proembryo of Alisma either presents variations, or the descriptions given by Hanstein and Famintzin are incorrect. At a later stage, three suspensor cells could still be seen (fig. 24), but whether these were the same as those seen in fig. 23, or represented cells which originated by subsequent divisions, I did not determine.

Summary.

The results of the investigation may be summed up as follows:

1. The development of the embryo-sac of Alisma Plantago represents nothing unusual, the fully matured sac having the usual eight nuclei.

2. During the conjugation of the two polar nuclei, the four centrospheres conjugate by couples, resulting in the formation of two new ones for the definitive nucleus.

3. The endosperm is not abundant and comes entirely from the division of the definitive nucleus, the antipodal cells showing no division or fragmentation.

4. The division of the generative nucleus of the pollen occurs in the pollen grain.

5. Both of the sperm nuclei enter with the pollen tube into the embryo-sac, but only the lower one takes part in the act of fertilization, the other one remaining in the tube.

6. The nucleus of one of the synergidæ is entirely absorbed when in contact with the pollen tube. The other one is later also dissolved, its substance being used probably to nourish the large nucleus of the suspensor cell.

7. The centrospheres of the lower sperm nucleus precede it as it approaches the oosphere.

8. The nucleus of the oosphere becomes bulged out on the side nearest the sperm nucleus, and its centrospheres being situated immediately opposite this bulge, travel slightly toward the approaching male nucleus.

9. All the stages preliminary to the conjugation of the male and female nuclei are favorable to, and indicate a conjugation of their centrospheres, at the time of impregnation of the oosphere.

10. After the first division of the oospore, in the development of the proembryo, the three succeeding divisions take place each time in the outermost cell, the first three divisions being transverse to the long axis of the embryo-sac, the fourth one longitudinal.

Ann Arbor, Michigan.

Explanation of Plates IX and X.

Fig. 1. A young nucellus with macrospore and remains of the tapetal cell at the upper end.

Fig. 2. Mature embryo-sac with eight nuclei.

Fig. 3. Two polar nuclei just before conjugation, showing the centrospheres joining in couples.

Fig. 4. Conjugation of polar nuclei; the attraction-spheres have fused; the centrosomes lie close together in the united attraction-spheres.

Fig. 5. Conjugation of polar nuclei; the larger nucleus is from the upper end of the embryo-sac.

Fig. 6. Advanced stage of conjugation of polar nuclei; the two couples of centrosomes are fusing.

Fig. 7. Embryo-sac, showing one of the synergidæ, the oosphere, the definitive nucleus of the embryo-sac, the three antipodal nuclei, and the pollen-tube containing two nuclei. The lower male nucleus is preceded by two prominent centrospheres.

Fig. 8. Embryo-sac with oospore dividing, and with endosperm cells.

Fig. 9. Pollen-grain with a large and a small nucleus.

Fig. 10. Pollen-grain, showing the small nucleus in stage of division.

Fig. 11. Pollen-grain with the division of the generative nucleus farther advanced.

Fig. 12. Mature pollen-grain with one large and two small nuclei.

Fig. 13. Upper end of the embryo-sac, showing the appearance of the conjugating sperm-nucleus after leaving the pollen-tube. Below this sperm-nucleus is the oosphere, while at the apex of the sac is the remaining synergida, and at the left of the latter is the second sperm-nucleus of the pollen-tube.

Fig. 14. Outer end of the ovule, showing the pollen-tube passing through the micropyle and into the embryo-sac.

Fig. 15. Upper end of the embryo-sac, with the pollen-tube absorbing the contents of the nucleus of one of the synergidæ, the latter being but lightly shaded.

Fig. 16. Embryo-sac, showing the two centrospheres of the oosphere and those of the lower sperm-nucleus in their usual position at this stage.

Fig. 17. Upper end of the embryo-sac; the oosphere is bulged out on the side toward the pollen-tube; the centrospheres lie some distance above this protuberance.

Fig. 18. Conjugation of the nucleus from the pollen-tube with the oosphere. Above to the right is the other sperm-nucleus, and to the left the remaining synergida.

Fig. 19. Embryo-sac. The upper nucleus of the pollen-tube still persists, as does also one synergida; while the oospore is in the segmented-skein stage, and the definitive nucleus of the embryo-sac has nearly completed division.

Fig. 20. First two cells resulting from the division of the oospore. The nucleus from one of the synergidæ appears at one side of the upper cell.

Fig. 21. Proembryo with three cells. The upper suspensor cell with its nucleus is becoming very much enlarged. In its upper end appears the nucleus of one of the synergidæ.

Fig. 22. Proembryo with four cells. Two endosperm nuclei appear free in the embryo-sac.

Fig. 23. Proembryo with five cells. The three nuclei in the embryo-sac are endosperm.

Fig. 24. More advanced stage of the embryo, showing three suspensor cells.

New North American Grasses.

F. LAMSON-SCRIBNER.

WITH PLATES XI–XIII.

Avena Mortoniana, sp. nov.—Gramen humile, caespitosum alpinum, perenne, 4–6-pollicare, paniculis paucifloris, 1–2-pollicaribus. Culmi erecti, rigidi, striati, glabri; vaginæ glabræ vel minute pubescentes superne; ligula plus minus semi-linealis, decurrens, lamina 4–6-pollicaris, lineam lata vel angustior, rigida, convoluta siccitate, subtus glabra, supra pubescens, minute scabra marginibus. Radii paniculæ singuli vel geminati, breves, erecti, 1–3 spiculas ferentes. Spiculæ plus minus 5 lineas longæ, bifloræ, flos secundus densissime hirsuto articulo rachillæ elevatus, plerumque imperfectus vel rudimentum, interdum omnino nullus, pedicella sola manente; glumæ vacuæ flosculos excedentes, lanceolato-acutæ, prima uninervis, secunda quam prima paulo longior, trinervis; gluma florens floris perfecti 4–4½ lineas longa, glabra vel superne scabriuscula, firmomembranacea praeter per margines scarios apicemque, dorso aristata prope medium; arista inferne contorta, geniculata, scabra, 7–8 lineas longa; callus basi glumæ florentis densissime pilosus, pilis sublinealibus; palea glumam aequans fere, lanceolata, carenis minute subdenseque ciliatis in dimidio superiore.—*Tab. XI.*

Allied to *Avena Hookeri* Scribn., from which it is distinguished by its smaller habit, shorter panicle, smaller and fewer flowered spikelets, longer bearded callus, and more densely plumose prolongation of the rachilla.

Mountain summits near Silver Plume, Colo., altitude 13,000–14,000ft. August. Nos. 697 *C. L. Shear* and 2,439 *P. A. Rydberg*, 1895. Rydberg's specimens were collected on Gray's Peak. Named for Hon. J. Sterling Morton, secretary of agriculture, in recognition of his interest in the promotion of the science of agrostology.

Danthonia Parryi, sp. nov.—Gramen erectum, subgracile, perenne, 1–2-pedale, vaginis marcidis culmos basi amplectantibus. Vaginæ glabræ praeter fauces, internodis breviores sed plerumque laminas superantes; ligula annulus breve ciliatus; laminæ 2–4 pollices longæ summæ plerumque breviores, innovationum hanc longitudinem excedentes, circa sesquilineam latæ, sensim in apices longiusculos filiformesque attenuatæ, minute scabræ per margines et nervo supra. Panicula simplex, 3–7 spiculis, axe commune pedicellisque subcompressis, scabrisque; spiculæ plus minus decem lineas longæ, 5–7-floræ; glumæ vacuæ membranaceæ ovato-lanceolatæ, acutæ, trinerves aut basi 5–7-nerves, subaequales, flosculos paullo superante; glumæ florentes quam vacuæ paullo firmiores, plus minus 7 lineas longæ, ovatæ, plerumque 11-nerves basi, trinerves superne, dorso marginibusque longiuscule sericeo-pilosæ, apice dentibus aristato-acutis. Callus longiusculus, lateribus dense barbatis. Arista 6–7 lineas longa, robusta, inferiore parte plana, laxe contorta, pallide-straminea, superiore attenuata, plus minus scabra. Palea plus minus 5 lineas longa late-ovata, brevissime ciliata per margines et apice acute bidentata.

This species has been referred both to *Danthonia sericea* Nutt. and *Danthonia intermedia* Vasey. It is distinguished from the former by the glabrous sheaths and leaves and more simple and strict inflorescence, fewer and larger spikelets, broader less acuminate and glabrous empty glumes, flowering glumes hairy upon the back as well as the margin, and stouter awns. It differs from *Danthonia intermedia*, to which it is more nearly allied, by its more robust growth, usually fewer and much larger spikelets, comparatively narrower empty glumes and more copiously hairy flowering glumes (in *Danthonia intermedia* the flowering glumes are hairy only along the margins); the teeth of the flowering glumes are also much longer, and the awn about twice as long.

My attention was first called to this species by some specimens collected by Dr. Parry in Colorado. It equals no. 2,397 *Rydberg*, collected in the valley about three miles north of Georgetown, Colo., August 19, 1895. It was distributed by E. Hall in 1862. No. 1,170–1 *J. Wolfe*, collected at Twin Lakes, Colo., appears to be the same thing, with much elongated leaves, and rather more numerously flowered panicles. The leaves in this form exceed a foot in length, and it may be designated as var. *longifolia*.

Zeugites smilacifolia, sp. nov.—Planta perennis; culmi validiusculi, simplices, 3–5-pedales, glabri, fusci, nitidi; vaginæ purpurescentes minutissime scabræ, pilis paucis papillatis superne juxta margines. Folia glabra, petiolata, inferiora remota, superiora approximata, usque ad 4 pollices longa, $2\frac{3}{4}$ pollices lata, basi subcordata, apice acuta, nervis primariis 11–13, arcuatis, venulis transversis inter se anastomosantibus utrimque distinctis; petioli graciles $\frac{1}{2}$–$1\frac{1}{4}$ pollices longi, basi pulvinis distinctis, apice pubescentes. Panicula 4 pollices longa, laxe patens, paucispiculata, ramis gracilibus inaequalibus plerumque geminatis. Spiculæ virides 3–$3\frac{1}{2}$ lineas longæ. 2–3-floræ; glumæ vacuæ inaequales, prima paulo linea longior, latior quam longa, inaequaliter dentata, saepe 7-nervis, venulis transversis connectis, marginibus minute ciliolata; gluma secunda oblonga, truncata, quam prima brevior multoque angustior, 1–3-nervis, venulis transversis, apice lata minute ciliolata, flosculus femininus articulo racheos $\frac{1}{2}$ lineam longo elevatus. Gluma florens feminina, 2 lineis paulo brevior, dorsi scabra, basi gibbosa, apice late truncata inaequaliterque dentata, marginibus minute ciliolata, 9–11-nervis venulis connectis. Palea angustissima, glumam aequans, carinis apiceque dense pubescentibus. Gluma florens mascula, oblonga, dorso scabra, apice lata rotundata, 5–7-nervis, angusta palea paulo brevior.—*Tab. XII.*

Faucibus, prope Cuernavaca, Morelos civitate. 20 Nov. (Pringle n. 5,961.)

The leaves of this well-marked species resemble in outline and venation those of some species of smilax. The false petioles consist of two parts, one an evident continuation of the leaf-sheath which occupies the greater part, and an upper pubescent part, which is manifestly a petiole-like downward extension of the blade. From this latter part arise the eleven to thirteen primary nerves, like so many rays. The limits of these two parts of this false petiole are quite sharply defined, but there does not appear to be any point of articulation between them. The pulvini at the base of the pseudo-petioles cause the leaves to diverge.

The material in the National Herbarium does not permit a comparison with all the published species, and unfortunately the descriptions of some of the species are too brief to be of much value as means of identification. I present below a description of the genus *Zeugites*, and, as far as I am able from the specimens and publications, a brief characterization of the species. *Zeugites Munroana* Hemsl., from Guatemala, Hemsley himself refers to *Z. Galeottiana.* In the Index Kewensis *Zeugites Americana* Rupr., not Willd., is referred to *Z.*

Mexicana, and *Z. Jamaicensis* Rausch is referred to *Z. Americana* Willd. I think it very likely that *Z. colorata* Griseb., and *Z. Hartwegi* Fourn., are not distinct from *Z. Americana* Willd.

ZEUGITES Schreb.—Spiculæ 3–8-floræ, paniculatæ, flore inferiore femineo superioribus masculis. Glumæ 2 inferiores vacuæ latissimæ, apice rotundatæ vel truncatæ, saepe subdentatæ, inter nervos saepius transversim venulosæ; tertia florem fertilem fovens vacuis similis nisi paullo major; superiores 2–7-flores masculos foventes angustiores, venulis transversis raris; palea angusta, hyalina, 2 carinata.—Gramina nunc debilia basi decumbentia ramosa, nunc elatiora valida, foliis planis petiolatis vel sessilibus, ovatis vel ovato lanceolatis inter venas transverse venulosis. Panicula terminalis, nunc laxa effusa, spiculis paucis nutantibus, nunc dense floribunda. (Char. ex Benth. et Hook. Gen. Pl. **3:** 1191.)

Spiculæ 6–10-floræ.

Z. latifolia Hemsl. Biol. Centr. Am., Bot. **3:** 577.

Krombholzia latifolia Fourn. Mex. Pl. Enum., Gram. 122. (Leibm. n. 541).

Planta robusta, culmo valido, foliis subsessilibus, late cordatis, lanceolatis, 4-pollicaribus. Panicula pedalis fere, spiculis laevibus 5-lin. longis, 8–10-floris.

Z. Galeottiana Hemsl. l. c.

Krombholzia Mexicana Rupr. in Bull. Acad. Roy. Brux 6:—[n. 8.] (Galeotti n. 5,751).

Planta pusilla, foliis parvis, cordato ovatis, breviter petiolatis; panicula depauperata 3–4-spiculata; spiculæ 7-floræ, glumis vacuis parvis inequalibus, integris.

Spiculæ 2–4-floræ.

Z. Americana Willd. Sp. Pl. **4:** 204.

Apluda Zeugites L.

Culmi 1–2-pedales. Folia ovata, acuta 1–2 pollices longa, 6–10 lineas lata; petiolis glabris. Paniculæ rami inferiori ternati. Gluma florens femina aristata; arista erecta, glumæ dimidiam longitudine vel paulo brevior. Spiculæ 3-floræ, floribus masculis distantibus.

Z. Hartwegi Fourn. l. c. 121.

Despretzia Mexicana Benth. non Kth. (Hartweg no. 569).

Planta gracilis ramosa, pedalis vel ultra. Panicula paucispiculata; spiculis 3–4-floris glumis vacuis dentatis, pubescenti-ciliatis, gluma florens femina apice mucronata. Vide supra.

Z. Mexicana Trin. ex Steud. Nom. **2:** 798. [ed. 2].
Despretzia Mexicana Kunth Revis. Gram. **2:** 485. *pl. 157.*
Culmi graciles caespitosi, basi ramosi, repentes, geniculato-erecti. Folia ovata acuta, basi rotundata, petiolata. Paniculæ ramosæ depauperatæ patentissimæ. Spiculæ 3–4-floræ longe pedicellatæ cernuæ, lanceolatæ, virides. Glumæ vacuæ glabræ, longitudine subequales; gluma florens femina mutica.

Z. colorata Griseb. Flor. Br. W. Ind. 536 in obs.
Folia oblongo-lanceolata; petioli apice pubescentes; gluma florens femina breviter mucronata. Vide supra.

Z. smilacifolia Scribn.
Planta validiuscula. Culmi 3–4-pedales, simplices. Folia petiolata, usque ad 4 pollices longa, 2¾ pollices lata, petiolis apice pubescentibus. Panicula laxa, sub 4-poll. longa, paucis spiculis. Glumæ vacuæ inequales, dentatæ, scabræ, marginibus ciliatæ. Spiculæ 3-floræ, 2–3 lin. longæ. Gluma florens femina latissima, mutica, dorso scabra, marginibus ciliata.

Pringleochloa, gen. nov. Tribus CHLORIDEÆ Benth. et Hook. Gen. Plant. **3:** 1087.—Spiculæ monoicæ, dense biseriatim imbricatæ per latus racheos continuæ, complanatæ, ultra summam spiculam excurrentis. Spiculæ masculæ femininis dissimiles. Spiculæ masculæ unifloræ, rhachilla ultra florem in stipitem minimum producta; glumæ vacuæ 2, valde inaequales, prima quam secunda multo minor, uninerves, muticæ; gluma florens 3-nervis, apice breveter tridentata, glabra; palea glumam aequans 2-nervis; stamina 3, pistillus nullus; spiculæ femininæ uniflorae, glumis vacuis rudimentis multiaristatis 2–3 supra floram; glumæ vacuæ inferiores 2, valde inaequales, prima quam secunda brevior et multo angustior; gluma florens 3-nervis, aristis brevibus 3 inter dentes apicis; palea glumam aequans; stamina nulla, styli distincti, stigmata longe plumosa.

Gramen humile, perenne, stoloniferum, ramis gracilibus ascendentibus, foliisque brevibus subrigidis.

Dedicated to Mr. C. G. Pringle, who for many years has been collecting plants in our southwestern states and territories and in Mexico, and who has, perhaps, done more towards increasing our knowledge of the plants of these regions than any other collector.

Pringleochloa stolonifera, nom. nov.—Culmi stoloniferi ramis floriferis erectis vel ascendentibus 2–6 pollices altis. Spicæ masculæ 3–6, approximatæ, 8–20 spiculatæ ex vagina summa longe exsertæ, infima circa ½ pollices longa, superioribus deinceps sensim brevioribus, spiculæ dense imbricatæ, subsessiles, basi pubescentes, circa 2 lineas longæ; gluma prima angustissime lanceolata, apice subulata, circa 1½ lineas longa, secunda multo latior, glumam florentem subaequans. Spicæ femininæ 3–4 per axes communes breves confertæ, 4–6-spiculatæ, infima saltem in vagina summa inclusa; spiculæ cum aristis florum rudimentorum 3½ lineas longæ; gluma prima setiformis, prope 1½ lineas longa, parce et breviter pilosa; secunda lanceolata, quam prima longior, dorso sericeo-villosa, apice minute bifida, nervo medio valido in mucronem brevem aristiformem inter dentes excurrente, flosculi rudimenta plerumque 2–3, ad glumas vacuas inaequaliter aristatas reducti, stipitibus brevibus vel articulis rachillæ elevati.—*Tab. XIII.*

Thinly carpeting, here and there, the calcareous plains around Tehuacan in eastern Puebla, a region rendered arid by its situation on the west side of the mountain chain connecting Mt. Orizaba with the mountains of Oaxaca. (Pringle, no. 6,280.)

This singular grass is closely related to Bouteloua, but possesses a remarkably composite line of characters. It is monoecious like Buchloe, and, like that grass, has the staminate spikes raised on the taller upright branches of the culm and long-exserted, while the female spikes are almost concealed among the leaves at the base of the tufts, and are at least partially enclosed within the inflated leafsheaths. The appearance of the staminate inflorescence very closely resembles that of *Dinebra chondrosioides*, as figured in HBK. Nov. Gen. Plant. **1:** *pl. 53*. The spikelets, however, are strictly 1-flowered and staminate, and the prolongation of the rachilla behind the palea is a short bristle, and does not extend into a 3-awned rudiment. The pistillate spikelets agree in many respects with those of *Eutriana multiseta* Nees; they are very densely crowded on the short partial rachis, and appear as flabelliform clusters, but the awns of the flowering glume are much shorter, as are also the more numerous awns of the rudimentary florets above. These multi-awned glumes also suggest a relationship with Cottea and Pappophorum.

I have very little doubt of the identity of the species here described with *Atheropogon stolonifer* Fourn., the characters of which, as given by Fournier (Mex. Pl. Enum., Gram. 140), would apply to specimens bearing only female spikes. He describes the spikelets as hermaphrodite, but he may have too hastily assumed this, and overlooked their strictly unisexual character. Fournier's specimens, (Liebman no. 588) were collected in the same region, a fact which renders the identity still more probable.

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Explanation of Plates XI–XIII.

Plate XI. Avena Mortoniana Scribner.
Plate XII. Zeugites smilacifolia Scribner.
Plate XIII. Pringleochloa stolonifera Scribner.

Fig. *a.* Staminate spikelet, showing the back of the second glume, etc. Fig. *b.* Empty glumes of the staminate spikelet, more highly magnified. Fig. *c.* Lower part of the staminate floret, showing the short continuation of the rachilla behind the palea. Fig. *d.* Apex of the flowering glume of the staminate spikelet. Fig. *e.* First glume of the pistillate spikelet. Fig. *f.* Second glume of the same. Fig. *g.* Pistillate spikelet, dorsal view, empty glumes removed. Fig. *h.* Palea of the female floret. Fig. *i.* Fourth glume of the pistillate spikelet. The glumes above these have successively fewer arms. Fig. *k.* Rachis, to which were attached three female spikes.

Some aqueous media for preserving algae for class material.

W. A. SETCHELL AND W. J. V. OSTERHOUT.

There are ordinarily two difficulties in the way of introducing a careful study of the various marine and fresh water algæ into a course in cryptogamic botany. The first of these is the obtaining of the material, and the second is preserving the material which may be obtained in such fashion that it can be placed before the student in a condition to be readily examined and studied with nearly as satisfactory results as those afforded by the fresh material of the same forms.

The first difficulty can be overcome more or less readily. Fresh water species are more or less abundant in our ponds, brooks and rivers, and the increasing facility of access to the sea brings the marine forms within the reach of many. Especially do the facilities offered by the marine laboratories, such as those at Cold Spring Harbor, N. Y., at Woods Hole, Mass., and at Pacific Grove, Calif., afford an opportunity for the teacher of botany not only to become acquainted with the algal forms and their use in the class room, but also to obtain and preserve a good supply of desirable species in the very best condition possible. Under the auspices of the Marine Biological Laboratory at Woods Hole, a Department of Laboratory Supply has been in successful operation for several years, and from it all necessary botanical material may be very satisfactorily and economically obtained.

The old method of preserving in strong alcohol shrivelled the specimens to such an extent that the use of strong swelling reagents (alkalies or acids) was necessary to show anything like the proper degree of detail of structure, and while these methods were good for the ordinary tougher species, and when applied by students of some experience, yet they were very unsatisfactory when applied to the more delicate forms or when used by the more inexperienced manipulators.

The use of the weaker alcohol, 50–70 per cent. according to the particular specimen to be preserved, was better, yet proved decidedly unsatisfactory for the more delicate forms.

The ordinary English method of fixing in a saturated solution of picric acid and preserving in strong alcohol is a very good one, especially for specimens to be imbedded in paraffin or for special work in connection with particular problems. Better still is fixing in some special solution such as a saturated solution of picric acid, 0.5–1 per cent. chromic acid, Perenyi's fluid, Hermann's mixture, etc., and transferring through the ordinary grades of alcohol, or by dialysis, up to 70 per cent. strength and preserving in that.

Such material is in excellent condition for imbedding in paraffin or celloidin, but for the ordinary class work, for manipulation by the student himself, the specimens must generally be transferred again to water.

But the preparation by these methods of material for a large class is often a considerable task. The more delicate forms too are seldom in a thoroughly satisfactory condition.

It has been found to faciliate the class-work on all the cryptogams very much to use freezing methods in the preparation of sections for the class, and either to have the sections cut by an assistant or by different members of the class at different times. A description of a convenient freezing device and methods of imbedding in aqueous media will be published by one of us in the next number of this journal.

Freezing methods and the preservation of natural form and size of the different parts with as little change as possible have rendered it very desirable that aqueous media be employed if possible for preserving fluids.

A number of fluids have been subject to experiment by the writers for about three years, particularly upon the abundant materials of all groups of algæ obtained at the Marine Biological Laboratory at Woods Hole, Mass. It is thought by the writers that these notes of their experience, while containing nothing especially new, may serve as useful hints to those who have before them the problem of providing and preserving cryptogams for laboratory purposes.

Chrome alum.

This substance was used by Guignard[1] for fixing various Laminariaceæ for the purpose of investigating the structure and development of the mucilage ducts. Later it has been tested at the Biological Station at Helgoland by Lotsy[2] upon

[1] Ann. Sci. Nat., Bot. VII. **15**: 1–46. 1892.
[2] Bot. Centralblatt **60**: 15–16. 1894.

the red algæ particularly as to the preservation of the cell-structure.

The writers have used one per cent. chrome alum in either distilled water or sea water carefully filtered through sand, according to the different habitat, for about four years. The algæ, carefully selected and washed free from dirt and debris, have been placed in it at once and preserved in it until needed for examination. The cell structure is well preserved in all cases. Very little washing is needed afterwards to allow staining by any of the ordinary staining reagents. Gelatinous intercellular substances, whether soft or more cartilaginous, are rendered firm but not especially opaque by treatment with it. Cyanophyceæ, Chlorophyceæ, and Rhodophyceæ do very well indeed. Phaeophyceæ, almost without exception, are rendered brittle in a short time, but while this renders them troublesome to manage, yet specimens prepared in this way and soaked out in water are excellent for study by crushing methods. It is the intercellular substance that is rendered brittle and such forms as species of Leathesia, Mesogloia, Laminaria, etc., when crushed, spread out and show the cell structure and cell arrangement in a very satisfactory fashion. The color is not retained perfectly, but is ordinarily retained more than by any other of the media we have tried.

The Chlorophyceæ lose all of their green, or nearly all. The Cyanophyceæ and Rhodophyceæ often retain considerable (especially if kept away from the light), generally at least enough to assist materially in the examination of the chromatophores, while the Phaeophyceæ lose very little of their intensity. Specimens preserved in chrome alum must be kept in glass-stoppered jars, carefully closed, as the solution is liable to become invaded by various molds. A little finely divided camphor-gum at the top will prevent this, as will also a small quantity of formalin. Chrome alum solution has a certain corrosive action upon metals, so that metal tops to the preserving jars should be avoided, and specimens to be sectioned free-hand or with the freezing microtome methods, should have at least the greater part of the alum removed by washing.

One per cent. chrome alum is also an excellent preserving fluid for use with fungi of the various groups, for the mosses, for ferns and for flowering plants, better in all cases than the strong alcohol commonly used, but probably not superior to the various percentages of formalin, except in the case of gelatinous forms. Spirogyra cells keep well in 1 per cent. chrome alum, the chromatophores, pyrenoids, nuclei and protoplasmic sac and threads showing very well indeed. Specimens kept in a cork-stoppered bottle in chrome alum showed a very distinct dark steel-blue stain affecting the nucleolus most, the nucleus and the chromatophores, and this remained after washing in water, dehydrating, and mounting in Canada balsam.

With chrome alum, as well as all other preserving media, a fairly large proportion of fluid should be used.

Formalin.

Formalin, formalose, or 40 per cent. formaldehyde, according to the trade name, has in the last two years become very popular with both zoologists and botanists. It is not necessary for us to go into the literature, but we have found that the 1–2 per cent. solution of the formalin (1–2^{cc} formalin in 99–98^{cc} distilled water or sea water) makes a solution sufficiently powerful to kill, fix, and preserve any ordinary vegetable tissue. While the color fades more rapidly than with chrome alum, the cell contents are preserved equally well. For Phæophyceæ, a 2 per cent. formalin solution is the very best fluid which we have tried. Cyanophyceæ preserve their structure but not the gelatinous matrix so well, since this is liable to shrink under the influence of formalin. Delicate Rhodophyceæ, such as Griffithsia, Callithamnion, Dasya, etc., keep their full form better than in any other fluid. Chlorophyceæ do equally well. Formalin solutions containing organic materials become acid after a short time and this may tend to alter the cell-contents or the intercellular substance slightly, but in preparations kept for nearly two years this is not sufficiently marked to be especially noticeable. Formalin in the same percentages works excellently for fungi and the higher plants. Toadstools are preserved in their natural shapes and in more or less of their natural colors according to the species.

Camphor water.

Camphor-gum is sparingly soluble in water, but the solution is very prejudicial to the life of microorganisms. Camphorated water is very useful when considerable collections have been made and cannot be examined for several hours.

In such cases small pieces of camphor-gum strewn in the water help to keep the algæ from putrefying until they can be studied or properly sorted and preserved. Formalin is useful also for this purpose, but the acidity produced changes the color quicker than is the case in camphorated water. For preserving Cyanophyceæ, camphor water keeps the cell structure well if present in large volume, proportional to the amount of material, but the coloring matter is soon dissolved. Chlorophyceæ, Phaeophyceæ, and Rhodophyceæ, if well sorted and cleaned, are well preserved in abundance of the fluid, even the finer details of cell structure being preserved perfectly. But perhaps the most important use of camphor water is to preserve specimens already fixed by other fluids. Specimens of the larger Rhodophyceæ, killed and fixed in concentrated aqueous solution of picric acid are preserved to especial advantage in camphor water; as one of us has experienced in special work upon *Rhabdonia tenera* Ag.

Summary of results.

Cyanophyceæ are best prepared with a solution containing 1 per cent. chrome alum and 1 per cent. formalin. This solution renders the gelatinous sheath and matrices firm, keeps the cell contents in a very natural condition, and retains in most cases the colors in their ordinary tints. 1–2 per cent. formalin solution preserves the cell contents very well indeed, but does not keep the color well, or the softer gelatinous sheaths and matrices. Camphor water is not very favorable for many blue-greens. Many species must needs be preserved in mass, and are associated with many bacteria and the camphor solution is hardly strong enough to wrestle successfully with the latter.

Chlorophyceæ are very satisfactorily preserved in any of these media. Chrome alum is to be preferred in most cases, but some species are rendered very brittle as, *e. g.*, membranaceous forms like Ulva Lactena. Such forms are of course better if placed in simple formalin solution.

Phaeophyceæ do well when placed immediately in 1 per cent. formalin in sea water. The larger forms are better fixed in 1 per cent. chrome alum for a few hours (3–6) and then preserved in 2 per cent. formalin solution or camphor water. But specimens for crushing may be allowed to remain indefinitely in the chrome alum solution.

Rhodophyceæ. The coarser forms may be put into any one of the three solutions and be in very excellent condition; chrome alum preserves more color than formalin or camphor water. For the finer study, specimens are best left in a concentrated solution of picric acid in sea water for twenty-four hours, then washed, preferably in sea water, for about twenty-four hours more, and preserved in camphorated sea water. Such genera as Nemalion, Champia, Rhabdonia, Cystoclonium, etc., respond best to this treatment. Delicate species need very careful consideration. Griffithsia Bornetiana is a most delicate species and, preserved in almost any way, collects itself together into a shapeless mass; the cells lose their shape, and it becomes a very uninviting object for study. But placed in 2 per cent. formalin in sea water with plenty of fluid so as not to be crushed, the cells keep their shape and the whole plant presents a life-like appearance as far as form goes. The color of course departs. The same thing is true of various species of Callithamnion, such as C. Baileyi, C. Borreri, C. seirospermum, etc. Dasya elegans has a way of dropping its hairs on being preserved, and the more delicate species of Polysiphonia break up into short pieces, but either formalin or chrome alum will prevent this if the specimens are fairly fresh when put into the preserving solution.

Berkeley, Cal., and *Providence, R. I.*

The purposes of ethno-botany.[1]

J. W. HARSHBERGER.

To the World's Fair in 1893 was brought a unique collection of objects obtained through the liberality of Mr. Hazzard by the Wetherill brothers in the Mancos cañon, Colorado. Never before in the history of American archæology had such a complete series of objects been brought together for study and comparison. The University of Pennsylvania was fortunate in securing through the efforts of Mr. Culin the loan of the entire collection, which stands unrivalled in showing a large series of interesting things; plant products in the form of food, dress, and household utensils being very largely represented. It is to the description of the plants and plant products that this article is directed.

Before describing, however, the objects which have been manufactured from plants, it is expedient to make a few preliminary observations on the importance of ethno-botany in general.

1. The study of ethno-botany aids in elucidating the cultural position of the tribes who used the plants for food, shelter or clothing. The well-known classification of men into savage, pastoral, agricultural and civilized will roughly serve our purpose. The term pastoral could hardly be applied to the tribes of North America. They were a roving people, traveling from place to place in search of game and settling only long enough to plant a little corn, beans and pumpkins to break the monotony of a too strict animal diet. Where they did not pursue agriculture, they subsisted on the seeds of wild grasses and herbs. The cliff dwelling peoples, probably driven to the mountain fastnesses, had practically left the hunter stage and had begun to enter the agricultural stage.

A people may be said to have left the pastoral and entered upon the agricultural stage, when chief dependence is placed upon the returns of the soil under cultivation. With the entrance upon this condition, new implements were devised, new methods of field labor introduced. An examination of

[1] A lecture delivered before the University Archæological Association, December 4, 1895.

the objects in the Hazzard collection clearly shows that they accomplished much by the use of very simple implements. The corn was planted by a pointed stick and hoed by a stick broadly flattened at one end. An examination of other manufactured articles of vegetal origin shows that these people were extremely provident; nothing was allowed to go to waste. It was too difficult a thing to carry the objects from below up the face of the cliff to their dwellings above, and they therefore exercised great care in putting everything to use. If it no longer served one purpose, it was devoted to another. Mr. Cushing has shown that this care was due to certain superstitions which they held concerning the soul of objects, animate and inanimate. For example, when the hollowed out pumpkin no longer served the purpose of a jar it was broken into pieces and the charred fragments served as a scraping instrument. The worn out fibers of Yucca were also conserved and made useful.

This careful husbanding of their resources may be directly traceable to two causes; first, it was difficult to carry large and bulky articles from the level of the cañon to the rocky shelves above, for in many cases steps had to be cut in the perpendicular face of the rock, climbing being facilitated by wooden climbing crooks, which afterwards were used by their descendants, the Pueblos, ceremonially; second, they lived in an arid region, where the materials ready at hand for the various uses of domestic life were extremely limited, and where the vegetal food supply was limited by the water supply, which in many seasons was very small. The panniers and baskets, made of cane grass with carrying frame attached, were very serviceable in transporting seeds and fruits from the campestrine levels to the cliffs above. The ladder in the collection, the rounds of which are bound to the uprights by yucca fiber, fulfilled essentially the same purpose. An examination of the collection also shows that they had advanced to the use of a double lever of the second class, for we find them employing a pair of cedar forceps which Mr. Cushing says were used to pick cacti, too prickly to be gathered in the ordinary way. In fact a large number of the objects as manufactured from plants shows that they had made considerable progress in the arts, and were less dependent, therefore, on the uncertain supply of food afforded by following hunting or fishing. In other words, they were to a certain extent independent of their surroundings and could, by planting crops, which they afterwards harvested and stored in granaries, eke out an existence.

2. An ethno-botanical study throws light upon the past distribution of plants. I have at some length shown[2] that a study of the native uses of maize, etc., leads to the belief that Indian corn was a native of southern central Mexico and from there by trade and barter was carried to the farthest points in North and South America. Another example is found in tobacco which was universally distributed throughout the American continents. The distribution of tobacco, however, is complicated by there being two or three species, which were used in different parts of the western hemisphere. One species (*Nicotiana rustica*) was cultivated by the Indians in New Mexico and Arizona, as observed by Dr. Edw. Palmer. Another species (*Nicotiana quadrivalvis*) was cultivated by the Indians from Missouri to Oregon. One or two species are recorded as having been cultivated in California.[3] One quotation will show that it was cultivated widely. Hernandez de Oviedo in his "Historia general de las Indias" (1535) describes the use of the plant in Sto. Domingo.

"Eine Kalebasse füllten die Indianer mit einem Kräuterpulver, das sie Cohobba oder Guioja nannten. In die Kalebasse steckten sie einfache oder gabelförmige Rohren, so dass eine oder beide Oeffnungen in die Nasenlöcher passten; denn die Insulaner rauchten ihren Tabak durch die Nase."[4]

The use of cedar was considerable. Cedar was used to make cactus pickers; cedar bark was twisted into headbands, woven into mats, and used in the broken up form as tinder. We find its use also in the eastern states, for in a collection of objects in the university museum taken from the Ohio mounds is a piece of a well preserved log although buried for hundreds of years. A microscopic examination shows the several cell wall layers still intact and the woody elements excellently preserved. These examples, with numerous others that might be taken from European archeology, for instance the existence of a peculiar variety of barley in the lake dwellings of Switzerland, prove that the study of plants in this way

[2]Maize: A botanical and economic study. Contrib. Botan. Laboratory Univ. of Pa. **1**: 75.

[3]U. S. Dept. Agr. Rep. **1886**: 76.

[4]A. B. Reichenbach, Die Pflanzen im Dienste der Menschheit. I. Der Tabak 2.

is of importance as deciding upon the original home and past distribution.

3. An ethno-botanical study helps us to decide as to the ancient trade routes. I have shown that maize was introduced into the West Indies by the tribes which had emigrated from the South American continent; that South America derived the cereal from the tribes living adjacent to the Rio Grande and tributaries.

Considerable difficulty, however, is experienced in the study of a single isolated plant, for the trade routes may have been various, but when we introduce as evidence two or at least half a dozen plants, we can determine with greater accuracy the main trade routes.

There cannot be any doubt that such trade routes existed. My grandfather used to narrate stories of the Indians that passed his father's house in central Pennsylvania on their way to the salt licks of Virginia. I remember seeing the trail that led southward through his woodland, as used by Chief Hogan and his band of hunters.

The discovery by Dr. Amos Brown of catlinite in the Hazzard Collection, also shows that the Indians of the southwestern United States had intercourse with the tribes residing in what is now the state of Minnesota. Mr. Joly says with relation to European archaeology: "How far the commercial relations of the primitive people of Europe extended and what routes they followed is a question the solution of which, like that of so many others, is as yet merely guessed at. However the presence of amber from the Baltic, and of white Mediterranean coral in Switzerland, Italy and elsewhere, of carved flints in abundance in the Isle of Elba where this rock does not exist in the natural state, arrows made of the black obsidian of Sardinia, found in the same island and in that of Pianosa, the jade axes found at Pauillac in the department of Gers; those of augite of Auvergne found in Brittany; the green turquoise of Brittany discovered in several dolmens in the south of France; all of these articles of which the rough material is foreign to the country where they are found, prove that from the earliest ages more or less commercial relations existed among the most ancient inhabitants of Europe." The same principles apply to the discovery of plant products in various parts of the globe. Commerce very early carried yew wood from the Rhine country to the Baltic, where the tree was and thence to the Esths and Wends where the yew was not found.

The first step in deciding upon the ancient trade routes is to ascertain (1) what plants were used by the cliff dwelling Indians, for example, of the Mancas cañon in Colorado, (2) to systematically tabulate the distant and local plants and (3) to discover, if possible the home of the non-indigenous plants. When all of these points are decided upon, we shall have sufficient data with which to map out the Indian trade routes.

There are several ways by which the plants as used by the cliff dwellers can be determined. (*a*) By a direct botanical determination of the species of plant used. This is possible in many cases when we have seeds, nuts, tubers, bulbs, and berries used as food; also by a botanical analysis of the pot herbs which may have the leaves and flowers preserved. An examination of the human excrement might disclose by means of the undigested voided seeds, the plants that were used as food. In dealing, however, with the raw materials of manufacture, it is often very difficult to determine from what vegetal source they were derived. (*b*) A microscopic examination of the plant product will reveal much; for example, if it be a piece of wood, its woody characters. We could determine by such an examination whether the stem was that of an angiosperm or that of a gymnosperm. In case the piece of wood shows a gymnospermic structure, it is quite possible by use of knowledge already gained to determine whether it be yew wood or that of the pine, the fir, the larch and the juniper. A microscopic examination of a dicotyledonous stem would also help us in identifying the wood.

We have a piece of wood before us which we cut in order to determine its microscopic appearance. A striking feature in such a section is the concentric circle of ducts in the early spring growth of wood; in the thick rings sometimes there are two or three rows of ducts, the third one being of smaller size than the others. "The first row forms in the spring as the leaves are opening." The largest duct is usually round and 0.13 of an inch in diameter; some are smaller and others flattened or elliptical. Except when first forming these ducts are never open, as usually stated, but are filled with delicate tyloses. Surrounding these ducts are small cells, which are termed tracheids, having minute thin places in their sides; the middle lamella of the cell, however, being not visibly perforated. Some cells containing starch are also intermingled with these tracheids. In an annual layer of vigorous growth large bundles or masses of hard, dense fibers are seen just out of the concentric circles of ducts, and when fully formed extend through the outer part of the layer. These fibers vary in diameter from .006 to .0075 of an inch. The medullary rays run through the bundles and at frequent intervals are intersected by cells running parallel to the axis of the tree, thus dividing a mass of hard fibers into small rectangles. Such a detailed description coincides with the structure of the white oak, and after applying further tests we can rest assured that the wood is from one of the most valuable of our forest trees.

If the study of the microscopic structure leads to no definite conclusion as to the nature of the wood, then we might have recourse to other methods. (1) The specific gravity of the specimen can be readily calculated whether the wood is heavier or lighter than water. A piece of wood tested in this way showed a sp. gr. of 0.4504. Upon comparing this figure with that of the tables in Sargent's voluminous work on the North American forest trees we find the number to correspond with that set down for chestnut wood. (2) An ash determination is also a means of discovering the species of tree from which the wood was taken. (3) The weight of the wood per cubic foot in pounds, and its fuel value are also means of deciding as to the kind of tree used.

We have now seven important facts concerning our piece of wood:

1. Its geographical habitat.
2. Its specific gravity.
3. Its microscopical structure.
4. Its fuel value.
5. Its resistance to transverse strain and compression.
6. Its weight in pounds per cubic foot.
7. Its ash.

We can judge as to the past meteorological conditions by an examination of the annual rings of wood, but the difficulty is to determine in the case of such woods as are to be found in the Hazzard collection, the year in which the wood was collected, whether at once or after the piece had lain on the ground for some time. We have, however, in the wood a valuable indication as to the years of drought and excesses of rainfall. A recent writer in *Forest Leaves* (**5**: 51) describes the irregularity of growth very forcibly and gives tables supporting his statements. He says: "Having observed, in cutting various timber trees, the irregularity of growth at different periods of tree life, and being interested in the striking coincidence of these irregularities with the occurrence of certain forest fires, an examination was made. On counting back the rings to where these irregularities occur, it was found that these checks, scars and decreased growth of rings denoted an interference with the regular healthy life of the tree, the result of forest fires occurring at these periods."

Having determined the wood as used by the Indians, the next thing is to determine whether the plant is indigenous or introduced into the locality. The place from which it came can in most cases be definitely located by botanical explorations.

4. Ethno-botany is useful as suggesting new lines of manufacture at the present day. This is especially true of woven stuffs. Mr. F. H. Cushing has shown that by unraveling the woven frabrics a clue can be obtained as to the manner of weaving. He has succeeded in imitating skilfully a large number of Indian stitches and has discovered many interesting and suggestive facts in connection with the early weaver's art.

The especial province of ethno-botany is to study microscopically the nature of the fiber employed, as in many cases new methods of obtaining raw materials from hitherto undeveloped sources might be suggested. Not that we have not improved on the methods of our ancestors, but the sedentary Indians of the arid districts of our country were extremely ingenious and put to the best use all the plants round about them. Again, we may learn by this study new uses of plants of which we were in ignorance. A stimulant and nerve tonic new to materia medica has been discovered in this way. Dr. D. Webster Prentiss discovered the action of the drug popularly known as mescal button, which is yielded by *Anhalonium Lewinii*. He obtained the supplies through agent James Mooney of the U. S. Bureau of Ethnology, who resided among the Indians of the southwest, especially the Kioways, for many years. It is to the use of the mescal button by the Kioways in their religious ceremonies that the white man owes his present knowledge of the drug.

The Indians assemble in their council tents usually on Saturday night, and seat themselves each with his supply of buttons, about a large camp fire, which is kept burning brightly. Button after button is swallowed from sundown until three o'clock A. M. Throughout the ceremony, there is no dancing or singing, but a continual monotonous beating upon drums is kept up by the attendants. The Indians sit in a blissful reverie for hours, enjoying the beautiful visions of color and other manifestations caused by the resulting intoxication. In fact, most of the plants which the new world afforded were made known in this way; tobacco, chocolate, the potato, maize, and tomato were first used by the Indians of North and South America and afterwards borrowed by white men.

One of the principal features of the equipment of every ethnological museum where ethno-botany is to be studied should be a collection of seeds, kept in glass bottles, and systematically arranged. The identification of all kinds of seeds collected from so many sources is impossible without such a collection.

"The seed collection of the Division of Botany, U. S. Department of Agriculture, is put up in glass specimen tubes without necks, and of two sizes, one 5^{cm} long and 1.5^{cm} in diameter, the other 10^{cm} long by 3^{cm}. In addition to the seeds, one or two capsules of the dry fruits are inclosed whenever possible. Fleshy fruits of our native wild plants are kept in a preservative fluid of some kind. Seedlings of economic plants in various stages of germination are also kept in alcohol for reference and study. The bottles are placed in cloth covered trays made of heavy binder's board. The trays for the smaller bottles hold 100 specimens. These are placed in one case, which is to contain also, so far as possible, herbarium specimens of the plants from which the seeds were taken. A card index to the collection is of great assistance in finding specimens."[5]

The equipment would not be complete without a series of microscopic slides, prepared to show longitudinal, transverse, and tangential sections of all our native woods. These should be indexed and catalogued in such a way as to be easily available for comparative use.

Lastly, an ethno-botanic garden should surround the museum building to provide living plants for study in connection with the objects of vegetal origin displayed in the museum.[6]

[5] Year Book of the Department of Agriculture **1894**: 408.

[6] HARSHBERGER, Museum and Garden. The Philadelphia Evening Telegraph. October 26, 1895. p. 5.

Only aboriginal American plants should find a place in such a garden. No plant can be found more graceful than maize, a grass associated with the myth of the aboriginal races of America and worthy the place as our national emblem. This plant has been little thought of for decorative purposes in our gardens. Yet it is decidedly ornamental and worthy of esteem. The sunflower, too, ought to be grown. The Indians recognized its value, for the Moquis and Supais planted it for food, and used the ground seed mixed with cornmeal as a dainty. The tobacco plant should not be forgotten, as it is decidedly ornamental.

The tomato with its crimson fruit, the pumpkin vine, the bean and the potato should find a place in some corner of the aboriginal American garden. The oak, yielding acorns, and the willow, dye stuffs, can be planted with good effect, while a pond, in which grow the arrow-leaf (*Sagittaria variabilis*) and yellow lotus (*Nelumbium luteum*), both furnishing aboriginal root-esculents, water cress, a salad plant, and wild rice, (*Zizania aquatica*), would serve to break the rigid outlines of the formal beds.

The plants should be arranged with reference to the Indian tribes which cultivated them. The plants of the Algonquin should stand apart from those of the Iroquois, those of the Aztecs from those of the Pueblos. Such a geographic arrangement is most desirable for educational purposes.

An arrangement according to the uses of the plants ought also be made. The strictly agricultural plants, such as corn, beans, pumpkins, etc., ought to be sown in one bed; the fiber plants, like basswood (*Tilia Americana*), sumac (*Rhus aromatica*), willow (*Salix lasiandra*), unicorn plant (*Martynia proboscidea*), yucca (*Yucca brevifolia*), in another; the dye plants, as alder (*Alnus incana*), celandine, smartweed, poke, white maple, gold thread (*Coptis*) is still another. The myth plants and medicine plants are important also, as showing the culture of the aborigines. They should by no means be excluded from this garden.

There can be no doubt, therefore, that such ethno-botanic gardens would stimulate greatly the interest in Indian plants, and at the same time they would be of the greatest scientific value. Nothing of the kind has ever been tried along the lines suggested, and such a garden would soon become a Mecca for those who desire to write upon our American plants and their uses among the aborigines.

University of Pennsylvania.

Notes on grasses.

GEORGE V. NASH.

My recent articles on "New or Noteworthy American Grasses," published in the *Bulletin* of the Torrey Botanical Club, seem to have caused considerable consternation among the agrostologists of the Department of Agriculture at Washington, judging from the haste in which they have criticised them. This haste has evidently led them into the commission of obvious errors, which would have been avoided had more care been taken in investigating the facts.

An exception is made to my disposition of *Agrostis brevifolia* of Nuttall. I am aware that until the type of this plant can be seen, absolute certainty of identification is impossible. The character given by Nuttall, to which your correspondent alludes, "culms solid and compressed

not terete but solid and ancipital," is one which is peculiarly applicable to the plant I have referred to Agrostis brevifolia, and which your contributor thinks is the *Vilfa Richardsonis* of Trinius. In the plant I have referred to Agrostis brevifolia the culms are solid, much compressed, and even ancipital. In the type of *Vilfa cuspidata* Torr., preserved in the Columbia College Herbarium, the culm, on the contrary, is terete with the exception of a slight flattening on one side, and never approaches ancipital in any degree. If this character is to be considered as "essential and decisive," it does not argue well for the equivalency of *Agrostis brevifolia* Nutt. and *Vilfa cuspidata* Torr.

Again, a lack of research is shown by your contributor in his disposition of Steudel's *Cryptostachys vaginata*. Steudel refers to the specimen, on which he founded his monotypic genus Cryptostachys, in the following words: "Panicum proliferum Hrbr. Amerc. un. it. 1837."[1] There is a specimen in the Columbia College Herbarium with a printed label bearing the above quoted words, and thus evidently a duplicate of the grass Steudel had in mind; it is undoubtedly the *Vilfa vaginaeflora* Torr. Steudel, like many others, applied Torrey's name to the wrong plant. But a careful consideration

[1] Syn. Pl. Gram. 181. 1855.

of the generic description given by Steudel should have availed to show that his Cryptostachys vaginata is *Vilfa vaginaeflora* Torr., for he says: "glumæ 2 . . . acuminatæ; valvulæ 2 membranaceæ pilosæ acuminatæ." These characters, especially the reference to the pubescence of the flowering scale (valvula), are found in Vilfa vaginaeflora of Torrey, and well distinguish it from my *Sporobolus neglectus,* in which the empty and flowering scales are never more than acute and perfectly glabrous. Besides the longer and relatively narrower spikelets in *V. vaginaeflora* Torr., another character serves well to distinguish these two related species. In Sporobolus vaginaeflorus the flowering scale in age is dull and usually mottled, while in Sporobolus neglectus it becomes white and shining.

The other of your correspondents seems to question the "validity" of some changes I have proposed, but he too disregards the facts. In reference to *Andropogon alopecuroides* L., it is perfectly evident that Linnaeus applied his name to a form with a twisted awn, for he uses the expression "aristis tortuosis." It makes no difference whether the twisting of the awn is of specific value or not. The only question is, to what form did Linnaeus give the name "alopecuroides." He has made himself clear on this point, as stated above. He also makes the following citation: "Andropogon culmo paniculato. Gron. virg. 133." On page 133 of Gronovius' Flora Virginica the above quoted words are found and appended is "Clayt. n. 601." I have been thus explicit, as a reference made by your correspondent to "Gronovius' number 133" leads me to believe that he has not investigated the matter very carefully, and the above words of explanation may help to set him right. He evidently inferred that the number 133 cited by Linnaeus referred to the number attached to some specimen. Had he looked into the subject, he would not have made this error.

In order to ascertain just what Clayton's no. 601 is, specimens of three distinct forms were sent to Mr. E. G. Baker at the British Museum, where Clayton's plants are deposited. He replied as follows: "Your no. 2 matches the Clayton type and as I thought perhaps you would like to see this for yourself I send a scrap of the type with Mr. Carruther's permission." This settled the matter conclusively. Bush's no. 160, collected in Missouri in 1893, and Kearney's no. 385, collected in southeastern Kentucky in 1893, belong here. Whether the *Erianthus saccharoides* of Michaux is the same or not must remain doubtful until his type is seen.

As to the separation of Panicum into a number of genera, this of course must be a matter of individual opinion. If it can be divided into groups, why not call these groups genera? At all events consistency should be used in the treatment of the subject. If it is thought best to make one vast genus out of all these related groups, it would seem better not to draw any arbitrary lines. Why should not Paspalum be included also, as it approaches Eupanicum as closely as does Syntherisma? How large is to be this aggregation? Cannot Eriochloa, Anthaenantia, Oplismenus, Ixophorus, Pennisetum, etc., come in with equal propriety?

Nothing new is added by your contributor to the argument in reference to *Panicum latifolium* L. As the matter has been referred to, it may be well to call attention to the work of Doell, for whose judgment your correspondent seems to have respect, as evidenced by his remarks in relation to Syntherisma. Doell[2] has applied the Linnaean name latifolium to the tropical plant, and cites *P. divaricatum* L. as a synonym. Among the synonymy, and heading the list, will be found *Bambosulus latifolius* Sloane, Voy. *pl. 71. fig. 3.* As Linnaeus refers to this same figure[3] it is not difficult to understand what he had in mind and whence he derived the name latifolium. If Linnaeus had in his possession, at the time of the publication of his first edition of the species Plantarum, the plant which Munro says is attached to the sheet bearing the tropical plant, would he not have referred to it in some way? Linnaeus simply says: "Habitat in America." Under P. clandestinum, published on the same page, he distinctly states that he had that plant from Kalm. Is it not clear that he received from Kalm, after the publication of his first edition, the plant which Munro says was ticketed, "From Kalm, North America?" At Kew the name has been applied to the tropical plant, as shown by a number of specimens in the Columbia College Herbarium determined by Prof. D. Oliver; among them nos. 2,053 and 3,593, Jenman, from British Guiana.

Your contributor says that my *Panicum boreale* is a form of

[2] Mart. Fl. Bras. 2[2]: 206. 1877.
[3] Sp. Pl. 59. 1753.

P. dichotomum, and may be separated as a variety of it. It is evident he has never seen the plant growing or he would hardly make this statement. Its habit is not that of P. dichotomum, but more that of *P. laxiflorum* Lam., from which it is abundantly distinct, both in technical characters and range. P. laxiflorum, so far as I am aware, does not occur north of Maryland. P. boreale, on the other hand, is a northern species, extending along the northern border of the United States. I have seen specimens from Newfoundland, Maine, Ontario, New York and Minnesota. It was collected by the writer at Cairo, in the Catskill Mts., N. Y., in 1893. It was quite plentiful there, and it was from field observations that my attention was called to its specific differences. The *P. laxiflorum* of Rand and Redfield's Flora of Mt. Desert (p. 175) belongs here.

The comments made on my disposition of *P. capillare* var. *minor* Muhl. are open to the same criticism made above in relation to P. boreale; your contributor is evidently not familiar with the plant as it occurs in the field. It is certainly as worthy of specific rank as *P. flexile* (Gatting.) Scribn. Are all these well-marked forms to be combined and this aggregation called a species? I will acknowledge this is an easy way to dispose of the matter, and entails little work on the author, but to those using the resulting work it is a constant source of confusion and disappointment.

Now as to the Ixophorus of Schlechtendal. Hackel[4] recognizes it, as being equivalent to Setaria, in the following words: *Ixophorus* Schlecht. ist eine einborstige *Setaria*." In the "True Grasses" of Scribner and Southworth, a translation of the above quoted words occurs and no comments are added, although comments do occur in other parts or the same work. Evidently the authors were satisfied with thsi disposition of it. Nor are the above parties alone in this treatment of the case. In the Index Kewensis the same view is maintained. Hemsley[5] gives, as synonyms of Setaria uniseta, *Urochloa uniseta* Presl. and *Ixophorus unisetus* Schlecht.

Columbia College, New York.

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[4] Eng. und Prantl, Nat. Planz.-Fam. 7: 36. 1887.
[5] Biol. Cent.-Amer. **3**: 506.

Noteworthy anatomical and physiological researches.

On the twisting of the grain of pine.[1]

In 1854, A. Braun[2] published the results of extensive observations on the twisting of the grain in a large number of species of wood-producing plants, and offered an explanation for the phenomenon. The paper now under consideration contains the results of investigations on a limited number of allied species of conifers. Dr. Hartig agrees in part with Braun in his explanation, but does not agree with him as to the final cause of the twisting of the grain. The former assigns as the cause the peculiar manner in which the increase in the number of elements of the cambium occurs. As the woody axis of the tree increases in diameter the number of elements in the cambium cylinder at any height must increase correspondingly. This increase in the number of elements is secured not by division in a radial plane, but by transverse divisions. Usually these divisions do not occur at exactly a right angle to the long axis of the cell. As the two daughter cells produced by such a division, grow in length, the upper end of the lower one pushes its way upward and the lower end of the upper one grows downward, each insinuating itself between its mate and the neighboring element, separating to a slight degree the original elements of the cambium sheath, thus increasing its diameter.

These transverse walls are inclined both to the right and to the left from a radial plane. Between the relative members of these two kinds of wall and the twisting of the grain there is a close relation. Generally if the members are about equal the grain is straight. If a large majority of them incline to the right the grain winds in that direction; if to the left, the winding is in that direction. This is explained in the following manner. After each transverse division, if the wall inclines to the right, the tendency is for the upper end of the lower daughter cell to incline to the right, and for the lower end of the upper daughter cell to incline to the left. If now

[1] Hartig, Robert: Ueber den Drehwuchs der Kiefer. Forstlich-naturwiss. Zeitschrift 4: 313–326. Ag. 1895.

[2] Braun, A.: Ueber den schiefen Verlauf der Holzfaser und die dadurch bedingte Drehung der Baüme. Sitzber. der kgl. pr. Akad. der Wiss. Berlin, 1854.

other divisions of the elements occur in the same manner and in quick succession, the cells will all soon be inclined to the right, and in like manner if the walls incline to the left, the cells will incline to the left. The elements of the wood will be inclined as those of the cambium are inclined.

In all of the specimens examined, if any twisting of the grain occurred during the first thirty years of the life of the tree, such twisting was found to be to the left. In about half of the specimens the twisting in this direction continued throughout the life of the tree. In the other half twisting did not make its appearance until well along in the life of the plant (then to the right) or changed from the left to the right in from thirty to one hundred twenty years. The inclination of the long axis of the elements from a radial plane varied from one to ninety degrees. In a little more than half of the specimens the angle of divergence increased regularly with the age of the tree.—L. S. CHENEY.

The mechanics of curvature.

The much vexed question of the curvature of organs in response to various stimuli is again to the front, and a slight advance in the solution of the chief problem, *i. e.*, the immediate cause of the curvature, may be claimed. Noll in a recent contribution[1] meets the specific objections offered to his previous work[2] by Kohl[3] and Pfeffer.[4]

The principal theories which have been successively advanced in explanation of curvatures are chiefly as follows: Sachs attributed it to the exaggerated growth in length of the tissues on the side whose surface became convex in outline; DeVries to an induced heightened turgor of the convex side; Wortmann, in 1887, to the thickenings of the membranes of the concave side and aggregation of protoplasm in the cells limited by them, and consequences in growth extension. In the large amount of critical work following this last contribution it was established that the migration of the protoplasm and the thickening of the membranes on the concave side were attendant upon but bore no causal relation to cur-

[1] Ueber die Mechanik der Reizkrümmungen. Flora **81:** 36–87. 1895.

[2] Beitrag zur Kenntnis der physikalischen Vorgänge, welche den Reizkrümmungen zu Grunde liegen. Arb. d. bot. Inst. z. Wurzburg **3:** 496. 1888.

[3] Die Mechanik der Reizkrümmumgen. Marburg. 1894.

[4] Energetik der Pflanzen. Leipsic. 1893.–Druck und Arbeitsleistungen durch wachsende Pflanzen. Leipsic. 1893.

vature. According to the results of Noll's recent researches it seems somewhat conclusively demonstrated that the stimulus induces an increased plastic and elastic extensibility of the longitudinal membranes of the side of the organ afterwards becoming convex through the activity of the protoplasm, that these membranes extend in length from the pressure of turgidity, which is equal throughout the entire cross section, but the membranes of the concave side are unaltered and do not respond farther to it. That the extension of the membranes of he convex sides is not growth is shown by the fact adduced by Noll that they not only become thinner during the extension but do not increase in dry weight. The alterations in the properties of the cell wall which permit the extension are accompanied by changed reactions to staining substances. The fixation of the elastically and plastically extended cell walls of a curved organ is compared to the vulcanization of a stretched membrane of india-rubber; the protoplasm produces a substance which "vulcanizes" the extended wall and prevents the reflexion of the old curvatures to the initial stature of the organ when plasmolysed.—D. T. MAC DOUGAL.

Selection of organic foods by plants.

In a recent article, Pfeffer[1] has taken up the question of selection by plants from organic foods offered. If two carbon-containing compounds, each of which is present in a quantity sufficient to completely satisfy the demand for this kind of food, be offered to a plant at the same time, will both of these substances, either of which is capable of replacing (and thus protecting) the other, be used; and if this protection takes place, to what degree does it occur?

The experiments were conducted exclusively with the lower fungi, in most cases with *Aspergillus niger* and *Penicillium glaucum.* In the first series of experiments, two carbon-containing compounds of rather unequal nutrient value, dextrose and glycerine, were added to the nutrient solution in various proportions and the fungi in pure cultures were cultivated therein. The general result was that a choice was exercised in taking up the necessary carbon-containing material. Both were somewhat used, but the better food, the dextrose,

[1] PFEFFER, W.: Ueber Election organischer Nährstoffe. Jahrb. f. wissensch. Bot. **28**: 205. 1895.

was drawn on to a far greater extent than the glycerine, the latter being thus protected. In case the dextrose was present in small quantities, it was totally consumed before the close of the experiment and the glycerine was then used until the close. Although dextrose was able to protect in great part the glycerine, still, even when present in abundance, it did not do so completely.

When lactic acid took the place of glycerine, a similar general result was reached.

In case acetic acid, in food value approximately equal to glycerine and lactic acid, was offered with dextrose, a different result was reached. Although a poorer food than dextrose, the consumption of acetic acid was large, in cases exceeding, in ratio to the quantity offered, that of the dextrose. Here, the better food did not protect the poorer from use nor did the poorer protect the better. Why acetic acid is thus consumed at the same time with the dextrose, is a question which the author does not attempt to answer. He suggests, however, that it may be of special availability for the satisfaction of some single function. The suggestion of the satisfaction of single functions does not receive full discussion but indicates interesting possibilities.

When peptone took the place of dextrose in experiments similar to the above, very similar results were obtained. On the whole, peptone protected the poorer food more completely than dextrose.

By growing fungi in a mixture of dextro- and lævo-gyrate tartaric acids very interesting results were obtained.

While Pasteur, in 1858, found the dextro-acid was used, leaving the solution lævogyrate, Pfeffer found that while a majority of the forms used in his experiments acted similarly, almost as many showed no choice, using both kinds in like quantities. One form, a bacterium, chose the left-handed acid, leaving the solution dextrogyrate.

Pfeffer considers the causes influencing selection to be largely referable to plant regulation and therefore, a function of irritability.

In case of widely differing diosmotic properties, the material penetrating more rapidly than the other, though perhaps no better food, will supply the demand to a larger degree.

The stimuli prompting to a choice arise either from the plant's own products or from the substance offered. The quantity of reserves present and the concentration of the waste products belong to the former class of stimuli. The chemical nature, the food value of the substance and the mass offered are of the latter class.

Generally speaking, the better food is taken before the poorer, it being kept in mind that the individual peculiarities of the plant determine what constitutes a substance a good or a poor food. The extreme diversity as regards the chemical nature of substances used to supply the carbon demand is cited.

In order to speak more precisely concerning the values of materials used as food, Pfeffer introduces the "economic coefficient" of a substance for any plant in question. The "economic coefficient" of any substance for a given fungus is the amount of the dried fungus mass produced from the consumption of 100 parts of the food material.

The coefficients of dextrose and glycerine for the two kinds of fungi most used are as follows:

	Dextrose.	*Glycerine.*
Aspergillus niger	43	20
Penicillium glaucum	33	15.

RODNEY H. TRUE.

On the prevailing ombrophilous character of the foliage of tropical plants.[1]

A review of Wiesner's preliminary studies upon this subject in Europe was given in this journal in March, 1895. The present paper contains the results of his observations in Buitenzorg. It was proved, according to his previous experiments, that a distinction can be made between "ombrophobic" and "ombrophilous" foliage, and it was to be expected that this last form, the ombrophilous, would be the prevailing one in the moist tropical climate of Java.

The observations of Professor Wiesner show now, that the majority of the native and cultivated plants in Buitenzorg have ombrophilous leaves, but he observed, also, that ombrophobic leaves are not excluded. There are several plants of decidedly xerophilous character which tolerate the damp climate in this place. This is further illustrated by the fact that there is in the Buitenzorg garden a large group of Cacteæ and cactus-like Euphorbiaceæ, which thrive well in a place

[1] WIESNER, JULIUS: Pflanzenphysiol. Mittheilungen aus Buitenzorg. III: Ueber den vorherrschend ombrophilen Charakter des Laubes der Tropengewæchse. Sitzungsber. d. K. Akad. d. Wiss. math.-naturwiss. Classe **103**: 169–191. 1894.

which is exposed to the full effect of the sunlight. Among these are gigantic specimens of *Cereus pruinosus* and *cinerascens*, which have attained a height of six meters, a fact that seems to prove that such plants also may be able to tolerate a damp atmosphere. The author calls attention to the fact that the depression of transpiration in Buitenzorg is not so great as formerly stated by certain botanists. Indeed, it is not unusual to see that several plants show the effects of the exposure to the sun by the wilting of their leaves. The strong imbibition of the cell membranes of the leaves allows a considerable transpiration to take place even in an atmosphere which is almost saturated with moisture. It is, therefore, not correct to suppose that the plants in the damp climate of Java are only able to transpire in a very small degree. There are in Java several plants which really need considerable evaporation but seem to thrive well in the moist atmosphere. This is due to the fact that such plants have gradually changed their character and very often, also, their habit. This is, for instance, the case with the cultivated rose, which has ombrophobic foliage, and which only produces very few leaves and small flowers in the garden at Buitenzorg. But the skill of the cultivator has nevertheless succeeded in producing a few specimens with large and odorous flowers. This is interesting, since, according to Teijsman,[2] there is not a single native species of *Rosa* in Java. Several varieties of these cultivated roses have changed their ordinary habit by keeping their young leaves hanging for quite a long time and by being deep red from anthocyan, before they attain the green color. Some other varieties, which were unusually leafy, showed that the ombrophobic character of the normal leaf had been modified in these. The tea-roses thrive well as a rule, but there are a few varieties of these which have, so far, entirely failed to develop.

The author discusses a number of other plants, the foliage of which is ombrophobic, and which shed their leaves after a continuous rainfall. Such plants are *Oxalis Plumieri*, *O. corniculata*, species of *Cassia*, *Acacia*, etc. It seems, altogether, to be characteristic of such plants, that they drop their leaves much earlier than those with ombrophilous foliage. But it has also been shown in all plants that the om-

[2] **Teijsman**: Catalogus plantarum quæ in horto bot. Bogor. coluntur. 250. Batavia 1866.

brophilous character becomes lost by age and that it is not acquired until at a certain stage of the development of the leaf.

A peculiar case is mentioned to show how *Mimosa pudica* is able to protect itself against the rain. The leaflets are ombrophobic but escape the effects of the rain by the closing of the entire leaf. The leaflets themselves are, however, quite easily wetted when separated from each other, and the sensitiveness of this plant seems to be an adaptation for withstanding an excessive rain.

In regard to the ombrophilous foliage, the author confirms the observations of Stahl.[8] These leaves show a distinct relation to exist between their shape and their easily wetted surface, viz.: the presence of hairs, a furrow-like deepening above the veins, the dripping-point, etc. It is, also, interesting to note the importance of the hanging of young leaves, which is commonly observed in Java. This seems to be explained by the fact, that such leaves are ombrophobic when young, but become ombrophilous at a later stage, and then begin to raise themselves in a more or less horizontal position.—THEO. HOLM.

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[8] STAHL, E.: Regenfall und Blattgestalt. Ann. du Jardin du Buitenzorg—11: 98.

BRIEFER ARTICLES.

Accessory Buds.—*With Plate XIV.*—The axillary buds of *Spiraea sorbifolia* L. are very conspicuous and are especially interesting because of the pair of large collateral accessory buds which are usually associated with them. There is no better plant than this for studying the nature of accessory buds, if taken when these buds are just making their appearance, say in June or July. During the winter the three buds seem to have no connection with one another, but when small the accessory buds are plainly seen to arise from the axils of the first two bud-scales of the axillary bud. (Fig. 1.) Occasionally only one accessory bud makes its appearance, and sometimes when both accessory buds are present the normal axillary bud aborts and results in apparently two axillary buds entirely separated from one another.

No other Spiræa examined had accessory buds, but other species belonging to the order Rosaceæ were examined, and wherever accessory buds occurred they were collateral with the axillary buds, and evidently axillary to the lower bud-scales.

In a cultivated species of cherry some of the nodes have simple axillary buds while others have one or more accessory buds of equal or almost equal size with the axillary bud; but as between these two conditions there was every degree of development present. The origin of the accessory bud was plainly seen to be the same as those of Spiræa.

There are no accessory buds on the wild cherry (*Prunus serotina* Ehrh.), but on examination of the rings left by the falling of the bud-scales at the beginning of this year's growth a small bud is seen in each of the lower scars. These buds would have been the accessory buds had they been conspicuously developed during the existence of the bud to whose scales they are axillary.

Accessory buds in Caprifoliaceæ, when present, are superposed and their character, if the same as in rosaceous plants, is not so apparent. *Diervilla trifida* Moench. gives excellent examples of this arrangement of the buds (fig. 3). Here two buds appear above each axillary bud and in case the axillary bud is in any way destroyed, the lower accessory on that side increases in size till it is equal to the axillary bud of the opposite side (fig. 4). The same arrangement is also found in several cultivated varieties of honeysuckle, as *Lonicera Halliana* L., *Japonica* and var. *aurea*, etc., while our native honeysuckle (*L. Sullivantii* Gray) has no accessory buds.

In all the representatives of the Leguminosæ examined where accessory buds are present, the axillary bud is removed a short distance above the axil of the leaf and a single accessory bud is situated in the axil. This is distinctly seen in *Amorpha fruticosa* L. and *Cercis Canadensis* L. In the honey locust (*Gleditschia triacanthus* L.) the thorns are somewhat removed from the axils and a small bud is situated in the axil of the leaf. It is thus evident that the thorns arise from the true axillary buds and the small bud in the axil of the leaf is an accessory bud.

In Vitaceæ is found another very striking proof that accessory buds are not anomalous in character but are axillary to the bud-scales or the undeveloped leaves in the bud. Here a glance at any of the buds will show a single accessory bud with the apex just apparent above the outer bud-scale. This is best seen in *Ampelopsis quinquefolia* Mx. No one would, from a superficial examination, suppose more than this one accessory bud to exist, but by sectioning the bud one and frequently two other such buds may be seen in different stages of development (fig. 10).

August F. Foerste has observed[1] a tendency of certain abnormal conditions to recur at more or less regular intervals in a specimen of elm studied by him. Much greater regularity is shown in the recurrence of definite nodal characters in Ampelopsis. The repeated series consists of three nodes beginning with the third node from the axis from which any ramial division in question arises. At the first node of this series we observe on one side the stem nothing but the leaf-scar, on the opposite side the remains of a tendril, a flower-cluster, or the scar left by the falling of one or the other of these. The second node of the series is frequently precisely similar to the first but on vigorous branches usually presents a compound bud in the axil of the leaf-scar. At the third node of the series there is no scar or organ opposite the leaf-scar while in its axil is a strong axillary bud with its accessories well developed.

There seems to be a gradual increase of power from the first to the third node of the series. At the first node the terminal bud produces either a tendril or a flower-cluster which becomes opposed to the leaf by the development of the axillary bud into the succeeding internode of the axis, and the accessory bud fails to appear. At the second node sufficient power may have developed to produce in addition to these an accessory bud in the position usually occupied by the axillary bud. This bud does not materially differ from the true axillary bud except in the degree of development. A section of it shows the two or three accessory buds within but they are not as far ad-

[1] Botanical Gazette **19**: 463. 1894.

vanced as the accessories of the true axillary bud. In the third node where the energy seems to reach a climax the terminal bud produces the succeeding internode and the remainder of the power is spent in forming and protecting a strong bud whose destiny is to develop a secondary axis the following season. The year's growth never ends with an uncompleted series, the crowning bud always belonging to the third node.

The wild grape (*Vitis cordifolia* Mx.) is precisely similar to Ampelopsis in all these characters, but in the cultivated varieties examined considerable variation was found to exist in the periods of recurring nodal characters. The node at which the terminal bud continues the main axis occurred in these varieties at intervals of three, five, seven or even nine, and though usually at odd intervals would sometimes occur in the fourth or sixth places. This variation is probably due to the unnatural conditions attendant upon cultivation, especially such as pruning.

Prof. Alphonso Wood considered[2] the tendrils of the grape abortive or transformed flower-stalks. This is not necessarily true. Both are axial developments arising from terminal buds and hence occupy similar positions, but it is no more correct to say the tendrils are abortive flower-clusters than that the flower-clusters are modified tendrils, which latter would be the more probable if either were true, because tendrils are produced during the entire growing season while flower-clusters appear for a very short interval only.

The accessory bud of *Juglans nigra* L. and species of Carya is very small and arises just below the axillary bud in the groove at the base of the petiole. Observations thus far indicate that the relative position of axillary and accessory buds forms a family character. Though *Juglans cinerea* L., being rather rare in this section, has not come under the observation of the writer, it seems to him a fair question whether Prof. Asa Gray may not be mistaken in stating[3] that in the butternut "the true axillary bud is minute and usually remains latent, while the accessory ones are considerably remote and the uppermost which is much the strongest, is far out of the axil; this usually gives rise to an extra-axillary branch." In no observed case are branches regularly produced by accessory buds, their office being simply to take the place of the axillary bud in case that is destroyed, or normally develops into some other organ, as do the axillary buds of Diervilla, which develops the fruit.

Possibly the upper and stronger bud in the butternut which usually

[2]Class Book of Botany 66, 75. 1880.
[3]Gray's Botanical Text Book. 1: 45. 1879. [6th ed].

"gives rise to an extra-axillary branch" is the true axillary bud, as the upper bud plainly is in Amorpha fruticosa, Cercis Canadensis, and the above mentioned Juglandaceæ.—GEO. H. SHULL, *Sulphur Grove, Ohio.*

EXPLANATION OF PLATE VI.—Fig. 1. Axillary bud of *Spiræa sanguisorba* L., the accessory buds just making their appearance.—Fig. 2. Same, the axillary buds fully developed as seen in the winter.—Fig. 3. A node of *Diervilla trifida* Moench.—Fig. 4. The same. One of the axillary buds has been destroyed and the leading accessory bud has taken its place.—Fig. 5. A node of *Cercis Canadensis* L.—Fig. 6. A node of *Amorpha fruticosa* L.—Fig. 7. Node and thorn of *Gleditschia triacanthus* L.—Fig. 8. A node of *Juglans nigra* L.—Fig. 9. A node of *Ampelopsis quinquefolia* Mx.—Fig. 10. A section of the bud of same.—Fig. 11. The first two nodes and the recurring series of three nodes of *Ampelopsis quinquefolia.*

Relations of cutinized membranes to gases.—During the course of some experiments on the relations of plant membranes to gases, I had occasion to make an estimation of the rate of diffusion of CO_2 through a grape skin, and obtained a somewhat unusual result. In this experiment a cleaned skin of a Concord grape was fitted, by means of sealing-wax, to one end of an open glass tube 30^{cm} in length and 5^{mm} internal diameter, filled with boiled water, inverted in a dish of mercury, and the water displaced by washed carbon dioxide (MacDougal, Exp. Plant Physiology 36, 37. 1895). By the exosmose of the gas the mercury column was slowly drawn upward into the tube, for seven days at the rate of 2.5^{cm} per day, and six days at the rate of 1^{cm} per day. At the end of this time the meniscus of the mercury column was against the lower surface of the membrane. The column remained stationary for eleven days and then slowly began to fall until ten days later it became stationary 1^{cm} below the membrane. It retained its height with barometric and thermometric variations, from Nov. 1, 1894, to Dec. 10, 1895, when the apparatus was accidently shaken so roughly that the vibration of the mercury column ruptured the membrane and the column fell in a few minutes. An examination of the grape skin revealed a heavy cutinization of the outer walls as well as in the ten to fifteen layers of cells of which it is composed. The inner layers of the epidermis in some instances showed intercellular spaces, so that only the extreme outer layers can be taken into account in the consideration of the resistance to filtration, which in the present instance lasted thirteen months under pressure of 29^{cm} of mercury. This absolute resistance of the membrane to filtration for such a length of time has not been duplicated in any case whose records are accessible to the writer. Miss Golden details experiments with the resistance of grape skins to filtration under pressure of 44.5^{cm} of mercury for nine days (Proc. A. A. A. S. **43**: 277. 1895.) and Wiesner found in a similar experiment a grape skin which sustained a mercury column 70^{cm} in height for seventy-five days. The membrane is believed to have shown an absolute or nearly absolute resistance to filtration by atmospheric gases during the time mentioned in my experiment, since the upper surface of the column and the tube showed a discoloration indicative of the decay of the coloring matter from the lower side of the membrane. The gas evolved during the disintegration would be of sufficient amount to allow the fall of the mercury column.—R. N. Day, *Minneapolis, Minn.*

Hamamelis Virginiana.—Notes in a recent number of the Gazette regarding the dissemination of seeds of *Hamamelis Virginiana* recall my first acquaintance with its powers of propulsion.

In August, 1890, a visiting friend to whom the plant was new brought a branch to the house and placed it over a mirror. The next afternoon (some twenty-four hours later) as I was sitting alone in the room my attention was called to occasional cracking sounds which investigation proved to be caused by the propulsion of these seeds.

By evening most of the capsules were found to be empty, and those not so were emptied during the following day. No measurements were taken, but I distinctly remember that a number of the seeds were thrown to the opposite side of a 17-foot room.

I mention this as showing that the propulsive power is acquired as the capsule becomes dry, even though the stage of maturity is not reached.—Bessie L. Putnam, *Harmonsburg, Pa.*

EDITORIAL.

WITH THIS NUMBER the BOTANICAL GAZETTE passes into the possession of the University of Chicago. The only change that will be apparent to readers will come from the much larger opportunity of serving botany, for the same editors will remain in charge, and the general purpose of the journal will continue to be the same. The establishment of a Department of Botany, and the appointment of the senior editor as head professor, justifies the University of Chicago in assuming financial responsibility for the publication of the GAZETTE, which has been brought to its present standing by private enterprise. That this has been possible demonstrates its adaptation to the needs of American botanists, as well as their cordial appreciation. Now that it is about to enter upon a period of strong financial support it expects to meet these needs in the fullest possible way, and more abundantly deserve the good-will of its readers.

It should be clearly understood that the GAZETTE is to be even more freely open to the botanists of the world than it has been in the past. It is not to be the organ of the botanical department of any university, but it belongs to all botanists everywhere. Its relation to the University of Chicago is simply to bring it that permanence and possibility of development which the present condition of botanical science demands.

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THE FIRST paper in the last number of the *Minnesota Botanical Studies* might furnish an excellent text for a homily upon the abuse of the footnote. On one page, containing less than 300 words, there are no less than twenty footnotes! When the author says of Cypripedium, "The genus is represented in Russia[44], Germany[45] and other portions of Europe,"[46] she feels impelled to cite Ledebour and the Bot. Jahresberichte to establish these well-known facts. It would be almost as appropriate to cite the Century or Standard dictionaries as authority for the very words of the sentence. Such a volume of unnecessary references suggests too much the strutting turkey with feathers erected to produce an effect of size and weight beyond his real substance.

For the last paper entitled "A study of some Minnesota Mycetozoa," Mr. Sheldon deserves severe censure. We have known Mr. Sheldon heretofore as a student of the very difficult genus Astragalus, in which his work has received sharp criticism, some undeserved and some doubtless deserved. His appearance as a reviser of genera in the far more obscure Mycetozoa is therefore a great surprise. It is quite impossible to believe that a student of as few years standing as the author of this paper can be entitled to speak upon both Astragali and Mycetozoa. Had Mr. Sheldon confined his publication to a list of Minnesota Mycetozoa, under names accepted by any monograph, he would have done a real service. But when in a list of forty-two species he proposes twenty-five new names (with long lists of synonyms in which we can have no confidence), he not only stultifies himself but does irreparable harm. The case, however, is even worse. Not content with dumping about the Minnesota species the rubbish of worthless names constructed from book synonymy, Mr. Sheldon proceeds to "indicate" the nomenclature of sixty-odd species with which he had no immediate concern. It is difficult to refrain from imputing unworthy motives in censuring such a flagrant abuse of liberty of publication.

While Mr. Sheldon is the chief sinner, we cannot but feel that the editor of the *Minnesota Botanical Studies* by permitting the publication of this paper, has, not only done harm to the science of taxonomy, but has put into the hands of conservatives in nomenclature a keen weapon which they will not hesitate to use against the advocates of reasonable reforms.

CURRENT LITERATURE.

Two new books for secondary schools.

Probably the most puzzling problem in botanical book-making is the preparation of a suitable book for secondary schools. The factors in the problem are limited time, little or no equipment and poorly trained teachers. In the higher stretches of education these factors disappear or at least such an assumption can be made. Many have been the attempts to solve the problem, but in most cases the demand for time, equipment, and training has been larger than the supply. Professor T. H. MacBride, of the University of Iowa, is the latest to enter this field with his "Lessons in Botany."[1] His theory is to be of the greatest advantage to the greatest number, and hence he seeks to give the necessary science training through the use of what are called "the common plants." This of course means the plants of popular knowledge. In accordance with this theory trees are first introduced by a study of buds, followed by stems, roots, leaves, inflorescence, etc. Then follows a series of types, with no special sequence further than convenience in securing the material. The last six of the fifty-four lessons are given to cryptogams.

The text is almost entirely in the form of laboratory directions, only those portions of it being didactic which are necessarily so to fill out the subject under discussion. Professor MacBride has followed out his theory in a very systematic and clear way, and the book will no doubt be very useful because usable, in the secondary schools, certainly far more so than many of its predecessors. We do not agree with Professor MacBride's position that the "natural order" of presentation is opposed to the "logical order," and that it is more natural for students to take up a subject in the order "in which all science has been developed." If the "natural" order of presentation, which is the artificial one, is to be followed rather than the "logical" order, which is the natural one, only until teachers of the secondary schools have been sufficiently trained to present the plant kingdom from the standpoint of its evolution, that is, from the standpoint of nature, we are content. We question though whether even this is necessary.

The other book[2] has been prepared by Mr. Bergen, the teacher of

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[1] MacBride, Thomas H.—Lessons in elementary botany for secondary schools. Small 8vo. pp. xii + 233. Boston: Allyn & Bacon. 1896. 60 cents.

[2] Bergen, J. Y.—Elements of Botany. 12mo. pp. viii + 275 + 57. Boston: Ginn & Co. 1896.

biology in the English high school, Boston. It is divided into two separately paged and indexed parts, the first treating the topic announced in the title, while the second consists of a very much abbreviated flora (with a key), including "a few of the commonest spring flowers of the northern and middle states." This part, which is a mere publisher's trap to catch the unsophisticated teacher or school board, may be dismissed as not representing the author's ideas and as unworthy serious consideration.

The most praiseworthy feature of the book is the point of view, and the method advocated and necessitated if the book is adopted. The point of view of the author is the only one from which the mass of students will obtain any adequate conceptions of plant life. The plant is discussed as a living thing having relations to other living things and to its physical environment. The structure of this being is examined only so far as it is related to plant dynamics. This presentation of morphology and physiology is combined with directions for dissection or experimentation illustrating the points discussed. It is the first book of the kind which has come to our knowledge and its plan must be commended as most excellent.

But the execution leaves a good deal to be desired. In the first place the author has been unable to skake off the traditions of the past as fully as he ought to have done. This is manifest in the relegation of the "flowerless" plants to a separate chapter of twenty-seven pages, where they receive wholly inadequate treatment. It is further shown in the disproportionately elaborate treatment of the flower. To the morphology of the flower and inflorescence as much space is given as to all the cryptogams, while forty pages more are devoted to fertilization and the fruit. One sees also the survival here and there of the antiquated features of the earlier books, *e. g.*, in the discussion of the structure of those stems and roots only which have undergone secondary thickening; in the retention of "exogenous" and "endogenous" as designating stem structure; in the description of the bud as a cluster of leaf rudiments with no reference to the fundamental importance of the growing point, etc. The book is also curiously lacking in logical arrangement and in definitions. Nowhere is the student told what a leaf, stem or root is, nor is he led to discover how he can distinguish the one from the other.

But it must not be supposed that the book is largely bad. By no means. In the combination of a large amount of physiology and physiological experiments with the morphology and dissection; in the general accuracy of what is given (though there are some slips here); and in the selection of the abundant illustrations the book is a distinct advance upon its predecessors.

It is worth while noting the fact that both books are entirely dependent upon accompanying laboratory work, as indicating the profound change which is coming over the botanical teaching in high schools.

Plant breeding.

The second volume of the "Garden-Craft Series," by Professor L. H. Bailey, is before us in tasteful dress.[1] It deals with the very interesting questions regarding the breeding of plants to secure fixation of desirable features. The book consists of five lectures, covering topics presented to the author's students.

In the first lecture the causes for the appearance of new forms of plants, and the fundamental methods for fixing these forms and making them permanent, are presented. The influence of soils and methods of treatment, effects of climate, the change of seed, etc., are discussed. The second lecture expounds the philosophy of crossing as well as its advantage as a means of originating new varieties. In the third lecture specific rules for the guidance of the cultivator are laid down, none of which are to be found particularly set forth in this connection in other readily accessible writings. The fourth lecture consists of translations of Verlot's classification of varieties of ornamental plants, Carrière's discussion of bud variation, including a list of bud varieties, and Focke's chapter on the characteristics of crosses. In the final lecture, directions for the cross pollination of plants are given in detail, with illustrations. A brief glossary and a good index are appended.

We particularly commend this book to botanists, who have too long let the garden fence bar them from the study of some of the most interesting and instructive phenomena of plant evolution. The first three chapters will be found of especial interest and value.

We must take exception, however, to Professor Bailey's statement that "the ultimate unit or individual in growing plants is the bud and the bit of wood or tissue to which it is attached" (p. 8). And also to this: "This unit [in which variations arise] is the bud and the seed, —the one sexless, or the offspring of one parent; the other sexual, or the offspring of two parents." The confusion regarding the sexual phase of seed plants ought not to be perpetuated, even in popular books, as it is throughout this book. Regarding this topic it is quite possible to be accurate without being abstruse, and the sooner we cease to call flowers "sex organs" the better, for gardeners as well as for botanists.

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[1] BAILEY, L. H.—Plant breeding. Garden-craft series, vol. II. 12mo. pp. xii+293. figs. 20. New York: Macmillan & Co. 1895. $1.00.

But this morphological shortcoming will trouble too few, while the lucid and vigorous presentation of the chief matters will interest many, we hope.

General biology.

A second edition of the General Biology published by Professors Sedgwick and Wilson[1] ten years ago has given opportunity for a thorough revision and considerable changes in plan. The original plan provided for a general discussion of the fundamental properties of protoplasm and the forms of cells, followed by the thorough study of a plant (for which the bracken fern served as a type) and an animal (the earthworm). The difficulties in the use of the book arose from the exceedingly varied material necessary for the laboratory work on the first part of the book.

The chief changes in the present edition consist in the elimination from the body of the text of all laboratory directions, in lieu of which suggestions are made to teachers in an appendix; in the transfer of the study of the animals to precede the plants; and in the introduction of a series of unicellular animal and plant types.

The first change we think wise, but regret that the suggestions are too brief for those who need them at all. The second change, on the plea of the "ease with which the physiology of the animal can be approached; there can be no doubt that beginners find the nutritive problems of the plant abstruse," seems to rest upon a false premise. If beginners find the vital phenomena of a plant difficult to grasp, the fault lies with the teacher and the presentation—not with the character of the phenomena, which are vastly simpler than in the animal. The authors, who are zoologists, state their own experience, probably, and the reason may be valid in such cases; but their assertion that "there can be no doubt" is too strong for botanists to accept.

The introduction of the unicellular plants, protococcus, yeast, and bacteria, after the study of Pteris, seems to us an anomaly. Perhaps if a study of the physiology of protococcus preceded that of the bracken fern the authors would not find the latter so abstruse.

For the material of the book, the clear illustrations and the lucid style we have only praise.

Minor Notices.

YAKUTAT BAY, Alaska, was explored by Mr. Frederick Funston in the summer of 1892, under the direction of the Division of Botany of the Department of Agriculture. The results are just now published

[1] SEDGWICK, WM. T., and WILSON, EDMUND B.—An introduction to general biology. Second edition, revised and enlarged. 8vo. pp. xii + 231. figs. 105. New York: Henry Holt & Co. 1895.

(Jan. 15th) as vol. 3, no. 6, of the "Contributions from the U. S. National Herbarium." An interesting field report is presented by Mr. Funston, which well points out the peculiarities of the region. Mr. Coville, Chief of the Division, makes the botanical report, which consists of a catalogue of the 137 vascular species and varieties, and 27 bryophytes, with habitats and critical notes. We regret exceedingly to note that this government publication has adopted a new family nomenclature. A certain amount of discussion and agreement may be claimed in support of the use of the rules of the Botanical Club, but to supplant such names as Cruciferæ, Leguminosæ, Umbelliferæ and Compositæ, by Brassicaceæ, Fabaceæ, Ammiaceæ and Carduaceæ is the merest pedantry, and is straining after uniformity when uniformity is not necessary.

MINNESOTA BOTANICAL STUDIES, part 7, contains five papers. (1) On the genus Cypripedium with reference to Minnesota species, by Henrietta G. Fox, deals with the formally adopted state flower, with descriptions and geographical distribution in the state of the six species of the Atlantic region. (2) Poisonous influence of various species of Cypripedium, by D. T. MacDougal, in which he confirms his earlier observation, showing that the poisonous action is due to glandular hairs. (3) Tree temperatures recorded by Roy W. Squires. (4) Some Hepaticæ of Minnesota, by John M. Holzinger, is a list of 25 species. (5) A study of some Minnesota Mycetozoa, by E. P. Sheldon. Further editorial comment on nos. 1 and 5 will be found on p. 171.

A REPORT on collections made in 1894–95 by the Botanical Survey of Nebraska, conducted by the Botanical Seminar of the University, has just been issued. It is devoted to descriptions of new fungi and a list of additions to the reported flora of the state. The new species number fifty-five and the additions bring the state list up to 3,196 species.

MR. JAMES M. MACOUN, Curator of the Herbarium of the Geological Survey of Canada, is publishing a series of contributions from the herbarium. Numbers V, VI and VII are before us, reprints from the *Canadian Record of Science*, and contain additions to the flora, new stations, revised nomenclature and critical remarks.

THE "BOTANICAL SEMINAR" of the University of Nebraska has issued part 21 of its "Flora of Nebraska," containing the *Rosales*, by Mr. Rydberg. The handsome typography, good plates, and full treatment of the other parts continue. The statement of the relationships of various groups is full of interest, and careful synonymy blazes the way for those unfamiliar with the new nomenclature.

OPEN LETTERS.

Is publication of botanical and zoological papers in microscopical journals justifiable?

In the October GAZETTE in the column of "Notes and News," is this statement: "Botany and zoology are becoming badly entangled again with 'microscopy.' As something that deals with methods, the latter has an important place; as dealing with botanical and zoological results, it is out of its domain." Why the author of this paragraph makes use of the word "again" is difficult to see, for there has certainly been abatement neither in the recent nor in the remote past in the use of microscopical journals and proceedings for publication of biological papers. Indeed so far as my acquaintance with these journals goes there has been a steady increase of material such as the GAZETTE deems out of its proper place.

Is such publication justified by precedents? It is due the American Microscopical Society to say that it is by no means the first nor the only nor by any means the chief sinner in this respect. If the practice of putting biological papers into journals bearing a title indicating only that they are *microscopical* journals is to be condemned, then the leading English, American, and German microscopical periodicals at once become missionary fields for the GAZETTE note-writer.

A perusal of the following periodicals will show that papers dealing with botanical and zoological results predominate in all, and in some predominate almost exclusively. Other equally reputable titles might be added but this seems hardly necessary. Quarterly Journal of Microscopical Science, Journal of the Royal Microscopical Society, Journal of the New York Microscopical Society, Journal of Microscopy, American Monthly Microscopical Journal, Zeitschrift für wissenschaftliche Mikroskopie, Zeitschrift fur angewandte Mikroskopie.

Is such publication justified by necessity? It might be urged that these organizations should all change the titles of their publication. It would of course be impossible to limit them at once to methods as the writer suggests. The difficulty I take it is chiefly in the name. But who can suggest a better name for these organizations? Many have tried and have fallen back on their old name. The name any way plays a very insignificant part in the question as compared with the importance of having zoological and botanical subjects brought into the meetings. It is, it seems to me, very desirable to cultivate a taste for investigation in natural science in the minds of members of these societies. It is one of the most effective propaganda of which I know. It must be remembered that there are many workers now in biology in America and we know very well that the GAZETTE cannot give space to all the articles it would. Other botanical journals find their columns unequal to the demand for space. Every year the volume of matter published upon biological subjects increases. With this increase the labor of investigating increases but this should never be allowed to discourage the publication of investigations. It is a necessity both from the point of view of the investigator and from the point of view of the increasing multitude of readers that channels of publication should increase. Few of these channels have a more definite function to perform than the American Microscopical Society. Whether it is efficient in performing that function those who read its pages are alone able to tell. Its co-laborer, the GAZETTE, will be the last I am sure to discourage it in its mission.—W. W. ROWLEE, *Cornell University*.

Nature of the binary name.

In the January issue of the GAZETTE Professor Bailey has urged against the essential permanency of the specific name an argument of so much originality as to be worthy of careful consideration. He presented the same idea some five years since,[1] and I remember then regarding it as an argument needing to be answered; yet I do not recall having read anywhere a word of comment upon it. The gist of the Professor's argument lies in these two interrogations: "Is nomenclature monomial or binomial? Is *bullata* or *Carex bullata* the name of a sedge?" The two forms of expression are, of course, but the abstract and the concrete, respectively, of one thought. In other words, the query is but one; and its strength as an argument resides in the perfect confidence with which a certain one of two conceivable answers is expected. The propounder of this forceful question appears firmly to believe that any and every botanist gifted with ordinary human intelligence must answer: "*Carex bullata* undoubtedly, and not merely *bullata*, is the name of a certain sedge." If this be, what Professor Bailey so confidently believes it, the only rational answer; if it be the correct answer, the argument is strong enough utterly to discredit the practice of treating the retention of the earliest specific name as obligatory under the law of priority.

But, if what the author of the argument deems rationally out of the question be not only possible but defensible; if the affirmative answer to one of the questions does not necessarily involve the negation of the other; if both *bullata* and *Carex bullata* are names of a certain sedge, then the argument, so specious at first glance, is weakened, if not invalidated. And I shall venture to assert, having in mind the continual practice of all botanists, that, under certain limitations, *bullata* alone is the entirely sufficient name of a sedge. Professor Bailey will not dissent from such a proposition as this, that he could lecture for an hour, or for five hours, upon a certain group of sedges, discussing, the while, any number of species from a half-dozen to several hundreds, without any chance of indefiniteness or ambiguity as to the plants, and all this without using any but the specific names; never once, by any necessity of the situation, employing before his hearers the generic term *Carex*. Nor is this instance merely a supposititious one; precisely this usage being so exceedingly common that any botanist, at least upon a moment's reflection, must realize the universal prevalence of it. We do not, as a rule, make extensive use of anything but the specific names, in oral converse, no matter what the genus under consideration may be, unless it should be a monotypic one, in which

[1] BOT. GAZETTE **16**: 215.

case we as universally ignore the specific name, making the generic the mononomatic appellation of the species. What botanist, having occasion to speak of monotypes, like *Calypso* or *Arethusa* for example, employs the full binary name? There is no need of it; and, in an age less formal and pedantic than ours, no specific name would be assigned to monotypes, even in books and catalogues. The thing is wholly useless; at best a sort of rhetorical flourish appended to that simple term—that "monomial," to use, but not to approve a word so constructed—which usage makes the essential name of that species of plant. The name is even perfectly competent to distinguish that plant from all others; and so, in this instance we have a well warranted answer to Professor Bailey's question quite unlike any he deemed possible; a name of one term which is perfectly competent, and every way sufficient, to answer every demand but that of pedantry.

But, however extensively used the specific name as mononomatic may be, we can never say of this that it is the name by which a species may be absolutely distinguished from all other species of plants. So much must certainly be conceded to Professor Bailey. Nevertheless, it seems to me that he must feel himself compelled to admit that it has been just this extremely common oral treatment of the specific name as *the name* of a species which has led to the widely prevalent practice or retaining the first specific name under whatever genus; a practice which many have contended for as obligatory under the principle of priority, and which the most eminent and scholarly botanists of all ages have adhered to. Let me insist also upon this; that, in looking for fundamental principles, we are forced to make inquiry into oral usages; for these are everywhere anterior to written usages, and may have much to teach us.—Edw. L. Greene, *Washington, D. C.*

NOTES AND NEWS.

THE BELIEF that the nucleolus is not a permanent cell organ has been further confirmed by the observations of F. Rosen (*Bot. Centralbl.* 65: 115) in his studies of the root tips of Pisum, Phaseolus and Zea.

THE METHOD by which underground shoots gradually sink in the soil is said by A. Rimbach (*Ber. Deutsch. Bot. Gesell.* 13: 141) to be due to the power of forming contractile roots, especially when they are young.

IN HIS STUDY of the "oil tubes" of Umbelliferæ C. Van Wisselingh (Arch. Néerl. Sci. Ex. et Nat. 29: 199) concludes that the characteristic substance of the walls is neither suberin nor cutin, but an allied substance which he names "vittin."

DARWIN'S explanation of the nyctitropic position of leaves, that it is a protection against nocturnal radiation, has been controverted by E. Stahl (*Ber. Deutsch. Bot. Gesell.* 13: 182), who sees in the position a device to promote transpiration in the night and early morning.

A PATHOGENIC YEAST has recently been studied by Dr. H. Tokishige of Tokio (*Centralbl. f. Bak.*, 1te Abt., 19: 105). It is the cause of an infectious skin disease of horses in Japan. In artificial cultures it produces spores, and is named by the author, *Saccharomyces farciminosus.*

MR. JOHN K. SMALL has described (*Bull. Torr. Bot. Club*, Jan.) two new genera of Saxifragaceæ. *Jepsonia* is based upon *Saxifraga Parryi* Torr. and includes also *S. malvaefolia* Greene; and *Saxifragopsis* is based upon *Saxifraga fragarioides* Greene. Both genera are illustrated.

IT IS ANNOUNCED that the herbarium of the late Mr. Redfield, bequeathed by him to the Philadelphia Academy of Science, is about to be sold by that institution to form a nucleus for the Redfield fund of $20,000, to be used for the benefit of the botanical section of the Academy.

IT IS OF INTEREST to note that the protest against the old category of "parallel-veined" leaves is growing. L. Gabelli (*Malpighia* 9: 356) has pointed out that the greater number of cases so referred are but instances of palmate venation modified by the ribbon-like form of the leaf.

THE ANTHER of Loranthaceæ has been investigated by Van Tieghem (*Bull. Soc. Bot. France* 42: 363) with some interesting results. The number of "pollen-sacs" is remarkably variable, ranging from one to an indefinite number. It would be of interest to know whether "pollen-sacs" refer to the microsporangia, or to the "pollen-sacs" of ordinary usage.

THE "LATENT LIFE" of the seed has been a matter of much curious speculation. C. De Candolle has come to the conclusion (*Arch. Sci.*

Phys. et Nat. **33**: 497) that it is a case of "suspended animation." It is hard to imagine such a thing as "potential life," but easy to conceive of the necessary life exchanges being reduced to so low an ebb and flow as to be imperceptible.

THE EDITORSHIP of Queen's *Microscopical Bulletin* will hereafter be in the hands of Mr. Albert S. Baker. Mr. Edward Pennock, who has been the able editor of the *Bulletin* since its inception twelve years ago, has severed his connection with the firm, in order to establish a new depot for microscopical supplies. The journal will be continued without material change in form.

BULLETIN DE L'HERBIER BOISSIER for Dec., 1895, and Jan., 1896, contain papers of unusual interest to American botanists. In the former, the Mexican collection, known as *Plantæ Selerianæ* and determined by numerous specialists, is presented in part. In the latter, Renauld and Cardot discuss certain species distributed in their *Musci Americæ Septentrionalis Exsiccati.*

THE EXPLORATION of Central Africa is bringing to light many plants of great interest. Splendid forests of what are called "cedars" have been discovered on the Mlanje plateau, in British Central Africa. This "cedar" is a *Widdringtonia*, somewhat distantly allied to the cypresses. It seems now as though it is an isolated plant, somewhat like the Sequoias of our own Pacific slope.

NEW TERMS are constantly arising in botanical literature. One of the latest is "heterotopic," applied by F. X. Gillot (*Bull. Soc. Bot. France* **41**: 16) to those plants which are occasionally found on soils apparently very different from their normal substratum. The difference, M. Gillot shows, is more seeming than real.

THAT THERE IS NEED of some reconstruction of our views as to the development of the "embryo-sac" structures is evidenced not only by the fact that *Casuarina* has no antipodal cells, which seems to be true also of certain amentaceous genera, but now by the fact that *Corylus*, announced to be chalazogamic by Nawaschin, shows well-developed antipodals before the appearance of the egg-apparatus.

MR. HEMSLEY, in *Gardner's Chronicle* (Jan. 11th), gives a brief account of recent botanical discoveries in New Zealand, where botanical activity is very great. Hooker's *Handbook* of thirty years ago is the only complete account of the flora, but the *Transactions of the N. Z. Inst.*, now having reached its 27th volume, has been made the record of botanical discovery. In it about 550 new species of flowering plants have been described, but among them all there is but one new genus, and that an inconspicuous one.

THE VALUABLE COLLECTIONS of Mr. J. B. Ellis of Newfield, N. J., have been purchased by the New York Botanic Garden, together with a large part of his mycological library. It is a very large herbarium, and one of the most valuable in the country, containing numbers of type specimens, and rich in material illustrating the distribution of species. The Garden is to be congratulated upon securing so important a collection of fungi. It will shortly be moved to a fire-proof building in New York city to await the completion of the Museum Building at the Botanic Garden.

PROF. ALBERT N. PRENTISS, for many years professor of botany at Cornell University, has been compelled by prolonged ill health to resign his professorship. He has been elected *Professor Emeritus* by the Board of Trustees. The vacancy thus caused has been filled by the promotion of associate professor Geo. F. Atkinson to the professorship. Assistant professor W. W. Rowlee has been promoted to the highest grade of assistant professor. E. J. Durand, Sc. D., has been appointed instructor in botany, and K. M. Wiegand assistant. The courses of instruction have been reorganized and beginning with the next college year advanced and graduate courses in botany will be offered.

THE RECENT "Culver gift" of one million dollars to the University of Chicago for biological endowment has resulted in the establishment of a Department of Botany, in which Dr. John M. Coulter has accepted the head professorship. A large building, to be known as the "Hull Botanical Laboratory," has been planned, and its erection will soon be begun. The four stories of this building will contain ample space for lecture rooms, libraries, laboratories, and private research rooms for morphology, physiology, and taxonomy. Above the fourth story a large roof greenhouse will supply an abundance of living material under all conditions. As the building will not be completed before April of 1897, the full botanical staff will not be organized before the fall of that year.

IN A RECENT number of *Anatomischer Anzeiger*, Professor Conway MacMillan criticizes the statements of Dr. Beard regarding the resemblance between metazoan and metaphytic reproductive processes. The statement that "the whole of the cells of the gametophyte must be looked upon as morphologically equivalent, some becoming differentiated as vegetative organs by sterility, others retaining the primitive character of becoming conjugating gametes," is regarded as specially objectionable. It certainly seems to follow the morphological idea of Bower with reference to the sporophyte. Professor MacMillan homologizes metazoan and metaphytic reproduction by considering "the metaphytic coenogenetic spore a homologue of the metazoan blastomere." He does not see alternation of generations in animals as in plants, the reason of which he suggests lies in the "general automobility of sexual animals and the as general non-automobility of sexual plants." He concludes that "sporophytization is as essentially a plant character as cephalization is an animal." "The one is an expression in the organism of the static life, the other of the dynamic."

MR. J. E. HUMPHREY, in *Annals of Botany* (Dec.), discusses "some constituents of the cell." The problem of the nucleolus is taken up, and Zimmermann's view that it is a permanent organ combatted. Strasburger contends that it disappears or at least diminishes during nuclear division and is frequently ejected into the cytoplasm, and has proposed the theory that it furnishes the material for the spindle-fibers. Humphrey, in examining abundant material, confirms Strasburger as to the usual disappearance of nucleoli during karyokinesis and their reappearance in the daughter nuclei. All this, of course, militates against the idea that the nucleolus is a permanent organ. Humphrey has also examined Zimmermann's "sickle-stage" of the nucleolus, in which it occurs flattened against the nuclear membrane. Zimmermann has connected this phenomenon with the reduction of the chromosomes, and therefore finds it only in the first division of the spore mother-cell. Humphrey finds it in ordinary vegetative cells and not at all in the spore mother cells, and when found it is better explained as due to displacement by the unequal penetration of the fixing fluid, and hence of no significance.

The "centrospheres" are also discussed, and the fragmentary character of our knowledge concerning them emphasized, and also the difficulty of observing them in plants as compared with animals. All additional evidence, however, goes to show their uniformity, their permanent character, and their fundamental importance.

M. P.-A. Dangeard, in *Le Botaniste* (Jan. 10th), has published a very interesting illustrated paper upon the parasites of the nucleus and those of the cytoplasm.

Engler's *Die natürlichen Pflanzenfamilien* is rapidly approaching completion. Parts 126–128 are now before us, containing besides several small families the beginning of *Labiatæ* by Briquet.

The Division of Forestry has issued as its tenth bulletin "an elementary discussion of the characteristics and properties of wood," by Filibert Roth, special agent in charge of timber physics. It is the first publication of its kind in English, in systematic and available form, and with special application to American timber.

Botanical Gazette

APRIL, 1896.

Notes on the North American species of Plagiochila.

ALEXANDER W. EVANS.

WITH PLATES XV AND XVI.

Only two species of Plagiochila are attributed to our limits in the first part of the Synopsis Hepaticarum, published in 1844, and the first of these two, *P. porelloides*, must be considered a form of the second, *P. asplenioides*. Three years afterwards, in the supplement to the same work, five additional species are given: one of these, *P. interrupta*, is here reported from Greenland alone; three of the others are species which Sullivant had described the year before and one of these, *P. macrostoma*, must be regarded as a synonym of *P. interrupta;* while the fifth species, *P. nodosa* Tayl., likewise published in 1846, is one of the many forms of *P. asplenioides*. Only four valid species, therefore, are left to our credit:—*P. asplenioides*, *P. interrupta*, and Sullivant's two species, *P. undata* and *P. Ludoviciana*.

A fifth species, *P. spinulosa*, is described in Sullivant's "Musci and Hepaticæ of the United States," published in 1856, but the specimens from which the description is drawn are very different from the true *P. spinulosa* (Dicks.) Dum. and form the type of a new species. In Dr. Millspaugh's recent "Flora of West Virginia," a sixth species is added, and this, together with the two described in the present paper, increases the total number of our species to eight. It is probable that others remain undetected, particularly in our southern and western states.

The Plagiochilæ so rarely produce organs of fructification that it is usually necessary to depend upon purely vegetative characters in distinguishing the species. The method of branching, the shape and arrangement of the leaves, the peculiarities of their margins and of their cells are all of extreme importance in this respect. The underleaves, on the contrary, are of less value than in most hepatic genera. They are present, occasionally at least, in all our species, but they are, in most cases, minute structures deeply split into slender hair-like divisions and at first sight bear much resemblance to clusters of rhizoids. A closer inspection, however, will show that their laciniæ are multicellular and that they proceed from a basilar membrane one or more cells in height. The cells of which these underleaves are composed are not like ordinary leaf-cells; they are smaller and have much more delicate walls; but, in two of our species, peculiar, more distinctive underleaves with leaf-like texture are sometimes produced, and these will be especially noted. In the following key, none except vegetative characters are considered.

Key to the species.

Stems creeping and radiculose; leaves not decurrent. 1. *P. interrupta.*

Stems ascending from a rooting caudex, normally non-radiculose; leaves more or less decurrent.

- Leaves rarely reflexed at the postical base, not forming crest-like lines parallel to the stem.
  - Margins of leaves either entire or denticulate, the teeth exceeding ten in number. . . . . 2. *P. asplenioides.*
  - Margins of leaves dentate, the teeth not exceeding ten in number.
    - Length of leaves averaging less than twice their width.
      - Teeth arising from a broad base; leaf-cells large. . . . 3. *P. Columbiana.*
      - Teeth arising from a narrow base; leaf-cells small. . . . 4. *P. Virginica.*
    - Length of leaves averaging more than twice their width.
      - Leaves obliquely spreading, forming an angle of 40°–45° with the stem, scarcely narrowed at the base. 5. *P. Floridana.*
      - Leaves widely spreading, forming an angle of 55°–70° with the stem, distinctly narrowed at the base. 6. *P. Sullivantii.*
- Leaves reflexed at the postical base, forming two crest-like lines parallel to the stem.
  - Postical margin of leaves plane and dentate beyond the reflexed base. . . . . 7. *P. Ludoviciana.*
  - Postical margin of leaves repand-undulate beyond the reflexed base. . . . . 8. *P. undata.*

1. PLAGIOCHILA INTERRUPTA (Nees) Dum. Rev. Jung. 15. 1835.

P. macrostoma Sull. Musci Alleg. *n. 221.*

P. interrupta differs from all our other species in several important respects. As a result of its prostrate habit, its leaves spread horizontally and are almost flat, so that the plant has much the appearance of a Chiloscyphus, while in its inflorescence it is autoicous and not dioicous as in typical Plagiochilæ. Lindberg considered these differences sufficient to separate it from the rest of the genus, at first as a subgenus,[1] but afterwards as a distinct genus to which he gave the name of Pedinophyllum.[2] This genus is maintained by Schiffner,[3] but, as Spruce[4] points out, the characters assigned to it are scarcely of generic value, though it might be well to consider them of subgeneric. Lindberg himself had little faith in its validity; four years after its publication, he placed *P. interrupta* in Mitten's genus Leptoscyphus.[5]

Plagiochila macrostoma was first definitely referred to *P. interrupta* by Austin,[6] though even Sullivant had doubted the permanence of his species. His specimens were found on old logs and on shaded banks instead of on calcareous rocks where *P. interrupta* usually grows in Europe, but they agree pretty closely with European specimens. The principal difference which he gives, the presence of underleaves, does not hold, as these bodies may also be found on European plants. The species has not been collected recently in the United States.

2. PLAGIOCHILA ASPLENIOIDES (L.) Dum. Rev. Jung. 14. 1835.

P. porelloides (Torr.) Lindenb. Spec. Hepat. 61. *pl. 12.*
P. nodosa Tayl. Lond. Journ. Bot. **5**: 268. 1846.

P. asplenioides is very widely distributed in northern latitudes, being found in Europe, Asia and America; it grows on stones in brooks, on rocks dampened by the spray of waterfalls, on the ground in woods, on shaded rocks and banks, and at the base of trees; and its stems are either loosely massed together or scattered among other bryophytes. Specimens vary greatly in size, in the position of their leaves, and

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[1] Not. Soc. pro F. et Fl. Fenn. **13**: 366. 1874.
[2] Cf. Acta Soc. Sci. Fenn. **10**: 504. 1875.
[3] Engler-Prantl, Die natürlichen Pflanzenfamilien 91: 89. 1893.
[4] Hep. Amaz. et And. 452. 1885.
[5] Musci Scand. 4. 1879.
[6] Bull. Torr. Bot. Club **6**: 85. 1876.

in the character of their leaf-margins; but the various forms may be at once distinguished from *P. interrupta* by their ascending habit, and from all our other species by their rotund or broadly ovate leaves with rounded apex. The leaves may be distant or imbricated, nearly plane or strikingly convex, obliquely spreading or deflexed, and their margins are entire, subentire or denticulate; in fact, several of these variations are often found on a single stem, the tendency in such a case being for the leaves to become more crowded and more toothed as the apex of the stem is approached.

The American forms with entire or subentire leaves were long ago separated from typical denticulate-leaved forms as a distinct species, *P. porelloides*. We find the first description of this plant (as *Jungermannia porelloides* Torrey) in the classical "Naturgeschichte der europäischen Lebermoose"[8] of Nees von Esenbeck, who had examined sterile specimens collected in New York. After comparing it with his *Jungermannia interrupta*, he states that it is more nearly related to *J. asplenioides*, differing in its "constantly entire, obovate-cuneate leaves with less reflexed dorsal margin." Dumortier does not enumerate it among his species of *Plagiochila*,[9] but Lindenberg both describes and figures it under this genus; it is also admitted into the Synopsis Hepaticarum, where, although it is placed next to *P. interrupta*, it is said to differ from *entire*-leaved forms of *P. asplenioides* in the gibbosity of its leaves, no other difference being stated. In all recent works on American hepaticology, *P. porelloides* finds a place and it has also been distributed in several exsiccatæ.

As early as 1849, however, Spruce doubted the validity of this species. In his valuable notes on the "Musci and Hepaticæ of the Pyrenees," he writes, "I have seen no specimens of *P. porelloides* which I can safely separate from *P. asplenioides*."[10] Forty years afterwards Lindberg[11] reduced *P. porelloides* to a subspecies of *P. asplenioides* giving one European and two Asian stations for the plant, which had heretofore been regarded as peculiarly American. The most important point of distinction which he gives is in the shape of the perianth; in *P. porelloides* this is stated to be "ovate-rectangular, well rounded at the base," while in *P. asplenioides*, it is said

[8] 1: 169. 1833.
[9] Rev. Jung. 14. 1835.
[10] Ann. and Mag. Nat. Hist. II. **4:** 105. 1849.
[11] Kongl. Sv. Vet. Ak. Hand. **23:** 34. 1889.

to be "obconic." I have found that the shape of the perianth depends to a large extent upon the presence or absence of fertilization. In Swedish specimens of *P. asplenioides* collected by Dr. Arnell, some of the perianths with unfertilized archegonia are distinctly rounded at the base, while in specimens of *P. porelloides* collected by Professor Underwood near Syracuse, New York, perianths with mature capsules are narrowed and subterete at the base. It is apparent, therefore, that Lindberg's point of distinction is of little real value. Dr. Schiffner[11] has already reduced *P. porelloides* to a simple synonym of *P. asplenioides*, and there seems to be no reason why we should not follow his example, particularly as forms of this species with entire or subentire leaves have long been recognized in Europe.

3. **Plagiochila Columbiana,** n. sp.—*Plate XV. figs. 1–10.* Sterile, brownish or yellowish green, loosely caespitose; stems ascending, simple or pinnately branched, rarely dichotomous, often sparingly radiculose; leaves contiguous or imbricated, widely spreading, broadly orbicular-ovate, antical margin decurrent, revolute, entire or occasionally bearing an acute lobe-like tooth, postical margin rounded at the base, plane or rarely reflexed, entire or irregularly 1- to 3-toothed, apex broadly truncate, usually bearing a few scattered teeth; underleaves either minute and subulate or larger, lanceollate to ovate, acute, entire or irregularly toothed or lobed; eafcells polygonal, with thickened walls and prominent trigones. Stems 1.5 to 3^{cm} long, 0.4^{mm} in diameter; leaves 1.6^{mm} long, 1.1^{mm} wide; leaf-cells from middle of leaf averaging 0.041^{mm} in diameter.

On boulders subject to inundation; Rock Creek, near Washington, D. C., J. M. Holzinger.

In general appearance *P. Columbiana* bears some resemblance to *P. asplenioïdes*; but, under the microscope, it may be at once distinguished from that species by the ragged outlines of its leaves and by the irregularity in the number and position of their teeth. The latter are frequently wanting in the lower leaves and they are always few in number; as a rule they are short and blunt but they are sometimes longer and become lobe-like in character. The leaf-cells of this species are much larger than those of *P. asplenioides* or of any other of our Plagiochilæ. The large underleaves described above

[11] Engler-Prantl, Die natürlichen Pflanzenfamilien 91: 89. 1893.

are quite unlike those commonly found in the genus. In some cases they attain a third the size of the leaves and their cells are very like the ordinary leaf-cells of the species. They are by no means frequent, occurring on about one out of every five stems examined, and it is rare to find more than one or two of them on a stem. When they do occur, however, they are persistent and may be found by the older, as well as by the younger leaves. It is to be hoped that fruiting specimens of *P. Columbiana* may soon be collected, as it would be of interest to learn whether or not these peculiar underleaves take part in the formation of the involucre.

4. PLAGIOCHILA VIRGINICA Evans in Millspaugh: Flora of West Virginia 497. *pl.* —. 1892.

Since the publication of this species, I have received from Professor Underwood specimens of the same plant, collected by himself near Washington, D. C., in 1891. They are a little more robust than those collected by Dr. Millspaugh and some of the stems show minute underleaves; otherwise the specimens agree closely.

5. **Plagiochila Floridana,** n. sp.—*Plate XV. figs. 11–17.* Dioicous; loosely caespitose, yellowish or brownish green; stems simple or dichotomously branched; leaves imbricated, rectangular or ovate-rectangular, slightly convex, obliquely spreading, antical margin decurrent, straight or nearly so, entire, plane or subreflexed at the base, postical margin narrowly and abruptly long-decurrent, straight and parallel to the antical margin, or slightly curved, entire or usually irregularly dentate, apex broad and truncate, either irregularly and deeply spinose-dentate or bifid with a shallow sinus and distant acuminate lobes; leaf-cells polygonal with thickened walls and evident trigones; underleaves minute, subulate; ♀ inflorescence terminal, subtended by one or two innovations; bracts two, oblong, antical margin reflexed, entire in lower part, margins otherwise irregularly spinose; perianth (young) shorter than the bracts, broadly obovate, bilabiate with ciliate lips, wingless or narrowly winged; ♂ inflorescence not seen.

Stems 0.5 to 1.5^{cm} long, 0.12 to 0.25^{mm} in diameter; leaves 1.1^{mm} long, 0.4^{mm} wide; leaf-cells in middle of leaves, averaging 0.023^{mm} in diameter.

Mixed with Lejeuneæ on decaying logs; Ocala, Florida, L. M. Underwood. Distributed in Hep. Amer. *n. 109* as *P. Ludoviciana.*

This species differs from *P. Ludoviciana* in its smaller size, in its manner of branching, and in the shape of its leaves, which are not widened out and reflexed at the postical base and whose antical margins are not strongly arched. It is near *P. dubia* Lindenb. & Gottsche as figured by Gottsche,[13] but the leaves are more imbricated and more deeply toothed than he represents and the perianth has longer cilia.

6. **Plagiochila Sullivantii** Gottsche MS.—*Plate XV. figs. 18–21* and *XVI. figs. 1–3.*

P. spinulosa Sull. Musci Alleg. *n. 219* [not (Dicks.) Dum.].

Dioicous; growing in depressed tufts, glossy, bright green varying to yellowish green and becoming brownish with age; stems simple or sparingly branched; leaves distant or subimbricated, widely spreading, slightly convex, varying in shape from narrowly ovate to obovate, antical margin slightly decurrent, straight or a little curved, entire, subreflexed towards the base, postical margin short-decurrent, arched, usually entire at the base but soon becoming incised-dentate, apex broad, either coarsely dentate or bifid with pointed, entire or denticulate lobes; leaf-cells polygonal, thin-walled and scarcely thickened at the angles; underleaves minute, split to the base into several capillary lobes.

Stems 0.5 to 1.5^{cm} long, 0.2^{mm} in diameter; leaves 1.2^{mm} long, 0.5^{mm} wide; leaf-cells in middle of leaf 0.019^{mm} in diameter.

Banks of rivulets, Alleghany mountains, Sullivant. On shaded rocks; New Hampshire: White mountains, James; Connecticut: Beacon Falls, Evans; Branford, Eaton; Pennsylvania: Canadensis, Mrs. Britton; North Carolina, in Lindenberg herbarium. Distributed as *P. spinulosa* in Musci Alleg. *n. 219*, in Hep. Bor.-Amer. *n. 9*, and in Hep. Amer. *n. 111.*

Some years ago Mr. W. H. Pearson of Manchester, England, expressed the opinion that this species was distinct from the true *P. spinulosa*, and a comparison of the two soon convinced me that such was indeed the case. I had hoped to name the plant in Mr. Pearson's honor, but upon consulting the Gottsche herbarium, I found that it had already been named in manuscript by that author. In addition to the material distributed by Sullivant, Gottsche had examined a specimen from the Lindenberg herbarium (labeled *Jungermannia*

[13] Mex. Levermosser *pl. 2.* 1863.

sertularioides Michx.), upon which he had discovered perianths. I have failed to find these organs in any of the material at my disposal, so I add the following description from Gottsche's notes: "perianthio ovato-cylindrico semi exserto non alato, ore rotundo compresso, labiis dentatis; foliis involucralibus conformibus, appressis." Some of our forms differ considerably from Sullivant's specimens, which we must regard as the type of the species; but no good lines of distinction can be drawn between them, as intermediate forms also occur.

The true *P. spinulosa* is a European species occurring in Great Britain and, more sparingly, in the western parts of the continent. It is extremely variable, but its numerous forms all agree in the characters of their leaf-cells, which have thick walls and strongly developed trigones, in marked contrast to the thin-walled cells of *P. Sullivantii.* It also differs from our species in its larger size and in its broadly ovate or obovate leaves, which are strongly arched over the stem at the postical base. Among our own Plagiochilæ, *P. Virginica* and *P. Floridana* bear some resemblance to *P. Sullivantii.* The former differs in its pale, dull color, in its broader leaves with shorter and more inconspicuous teeth and its slightly larger leaf-cells; the latter in the shape of its more obliquely spreading leaves and in its leaf-cells which have thicker walls and better developed trigones.

7. PLAGIOCHILA LUDOVICIANA Sull. Musci Alleg. *n.* 223. 1845: Amer. Journ. Sci. and Arts II. **1**: 73. 1846.—*Plate XVI. figs. 4–12.*

Stems 2 to 4^{cm} long, 0.2 to 0.3^{mm} in diameter; leaves 2.5^{mm} long, 1.2^{mm} wide; leaf-cells with slightly thickened walls and well developed trigones, in the middle of the leaf averaging 0.029^{mm} in length by 0.021^{mm} in width.

In this species the underleaves are of two forms: in the one, they are of delicate texture and are deeply split into slender laciniæ; in the other, they are leaf-like in texture and are either bifid or irregularly cleft with entire or toothed margins. The latter form is apparently confined to robust plants. Sullivant says that the ♀ inflorescence is terminal, but does not describe the floral organs. In the examination of a large number of specimens, I failed to find either kind of inflorescence. Many of the plants examined reproduced themselves vegetatively by means of the propagula, which have been well described for the genus in general by Spruce.[14] They are minute stems springing from the leaf-cells and bearing distant bifid leaves; in some cases they are very numerous and almost cover the surfaces of the leaves from which they spring. Similar propagula are sometimes found in *P. Floridana* and possibly in our other species.

8. PLAGIOCHILA UNDATA Sull. Musci Alleg. *n 222.* 1845: Amer. Jour. Sci. and Arts II. **1:** 73. 1846.—*Plate XVI. figs. 13–19.*

P. crispata Gottsche? Mex. Levermosser 71. *pl. 15.* 1863.

Stems 2 to 3^{cm} long, 0.2 to 0.3^{mm} in diameter; leaves 1.9^{mm} long, 0.8^{mm} wide; leaf cells with thickened walls and well developed trigones, in the middle of the leaf averaging 0.020^{mm} in diameter.

Like the preceding species, *P. undata* is usually sterile. I have examined a single imperfect perianth from specimens collected by Professor Underwood at Toccoa Falls, Georgia, and append a description of it and its bracts: perianth terminal, subtended by 2 innovations, 2^{mm} long by 2^{mm} wide, flattened, campanulate, bilabiate with ciliate lips; bracts two, 1.7^{mm} long and 2.6^{mm} wide, broadly cuneate, antical margin reflexed, denticulate, postical margin and apex irregularly dentate.

The Mexican *P. crispata* is with some doubt referred to this species. If Gottsche's figures are compared with those of *P. undata*, it will be seen that, although at first sight they are apparently unlike, the differences are of degree, rather than of kind. In *P. crispata*, the leaves are more strongly repand-undulate along the postical margin than in our species. The specimens of *P. undata*, however, which were collected by Rev. A. B. Langlois at Chinchuba, Louisiana, and distributed as no. 152 of "Hepaticæ Americanæ," show both extremes in this regard and seem to break down the distinction between the two species. Both *P. Ludoviciana* and *P. undata* are rather widely distributed in our Gulf states.

In conclusion I would express my thanks to Professor Underwood, who has loaned me his valuable collection of Plagiochilæ; to Mr. Pearson, who has given me permission to use his drawing of *P. Sullivantii;* and to Professor Schumann, who has allowed me access to the Gottsche herbarium, now preserved in the Botanical Museum at Berlin.

Yale University.

[14] Hep. Amaz. et And. 452. 1885.

Explanation of Plates XV and XVI.

Plate XV.

Plagiochila Columbiana Evans.—Fig. 1. Plants, natural size.—Fig. 2. Part of stem, antical view (× 6).—Fig. 3. Part of stem, postical view (× 6).—Fig. 4. Underleaf, small, normal form (× 32).—Figs. 5–9. Underleaves, larger form (× 12).—Fig. 10. Cells from middle of leaf (× 200).

Plagiochila Floridana Evans.—Fig. 11. Plant, natural size.—Fig. 12. Part of stem, antical view (× 12).—Fig. 13. Part of stem, postical view (× 12).—Figs. 14, 15. ♀ bracts (× 12).—Fig. 16. Young perianth (× 12). —Fig. 17. Cells from middle of leaf (× 200).

Plagiochila Sullivantii Gottsche.—Fig. 18. Plants, natural size.—Fig. 19. Part of stem, postical view (× 12).—Fig. 20. Part of stem, antical view.—Fig. 21. Cells from middle of leaf (× 200).

Fig. 19, from Musci Alleg. *n. 219;* fig. 20, from Hep. Bor. Amer. *n. 9,* after a drawing by W. H. Pearson; figs. 18 and 21, from Connecticut specimens, collected by the author.

Plate XVI.

Plagiochila Sullivantii Gottsche (cont.).—Figs. 1, 2. Parts of stems, postical view (× 12).—Fig. 3. Underleaf (× 32).

Figs. 1 and 3, from Connecticut specimens, collected by the author; Fig. 2, from Pennsylvania specimens collected by Mrs. Britton.

Plagiochila Ludoviciana Sull.—Fig. 4. Plant, natural size.—Fig. 5. Part of stem, antical view (× 12).—Fig. 6. Part of stem, postical view (× 12).—Fig. 7. Underleaf, small, normal form (× 32).—Figs. 8–10. Underleaves, larger form (× 32).—Fig. 11. Cells from middle of leaf (× 200).—Fig. 12. Part of leaf, showing propagula (× 32).

Figs. 4, 8–11, from Louisiana specimens, collected by Langlois; figs. 5–7, 12, from Florida specimens, collected by Lighthipe.

Plagiochila undata Sull.—Fig. 13. Plant, natural size.—Fig. 14. Part of stem, antical view (× 12).—Fig. 15. Part of stem, postical view (× 12).—Fig. 16. Leaf, postical view (× 32).—Fig. 17. Leaf, lateral view (× 32).—Fig. 18. Underleaf, lateral view (× 32).—Fig. 19. Cells from middle of leaf (× 200). All figures from Hep. Amer. *n. 108.*

A simple freezing device.

WINTHROP JOHN VAN LEUVIN OSTERHOUT.

The apparatus consists of a freezing chamber upon which the object is frozen, and two pails filled with ice and salt. The pails are so arranged that when either of them is raised the other is lowered, and in consequence, the cold brine, which forms as the ice melts, can be made to flow back and forth through the freezing chamber which is between the pails and connected with them by rubber tubing.

The freezing chamber is a hollow cylinder made of brass or of iron, nickel-plated both inside and outside. Fig. 1 shows a section of the chamber, actual size. The brine enters one of the tubes at the side and escapes by means of the other. Below the bottom of the chamber, *D*, the cylinder is furnished with a thread inside, by means of which a wooden plug, *C*, is screwed firmly against the bottom of the chamber. The wooden plug is held securely in the jaws of the microtome and prevents the conduction of too much heat from the latter to the freezing chamber.

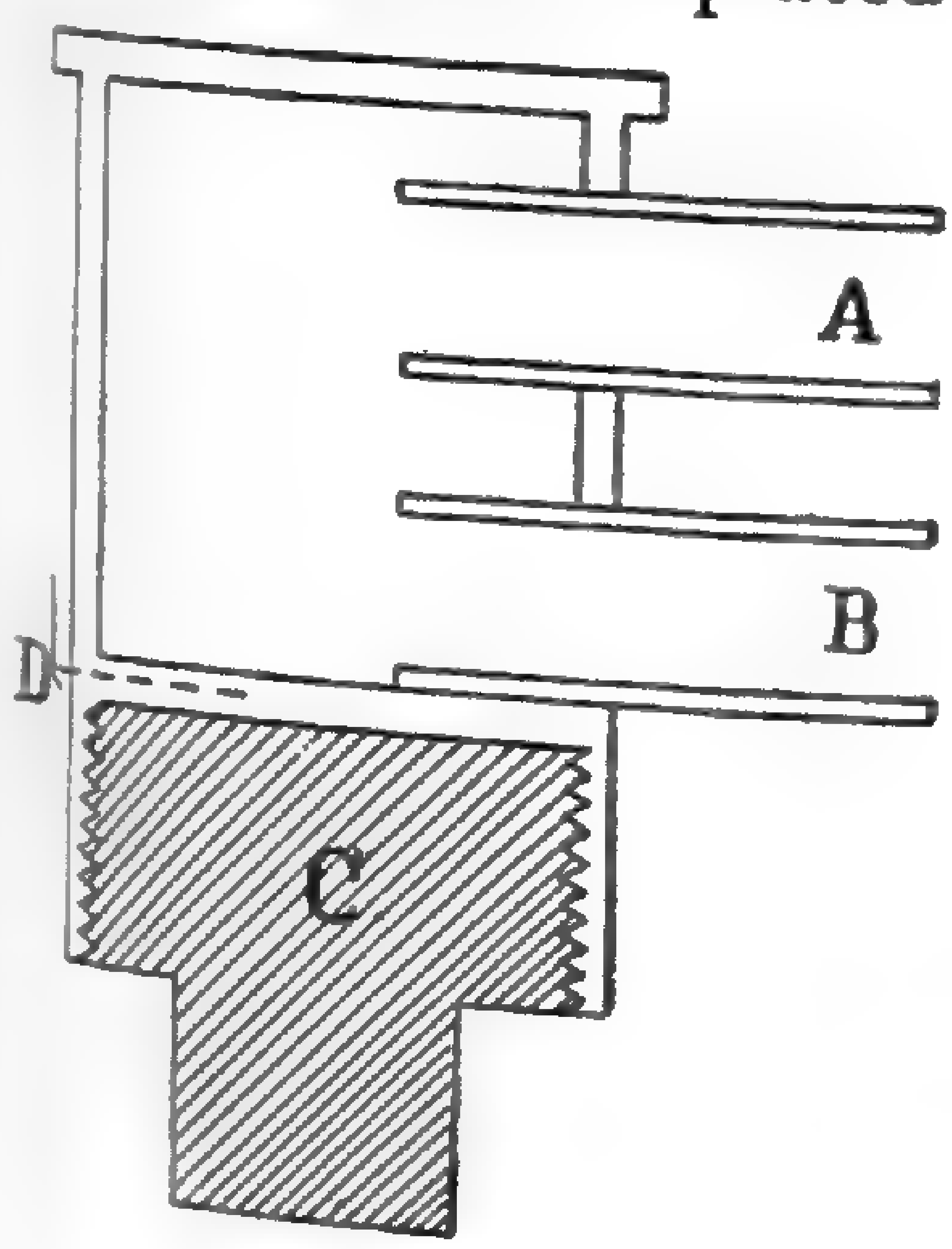

Fig. 1.

Large pails holding about five gallons are most convenient, since they contain ice enough to run the apparatus all day without being refilled. Smaller pails are just as serviceable if the apparatus is to be used for a short time only. Paper pails are best for the purpose, but ordinary wooden ones can be used. Each pail should be provided with a faucet capable of delivering a stream of water one-quarter of an inch in diameter; the faucet should be inserted about an inch from the bottom of the pail. The paper ice-water pails in common use answer the purpose perfectly.

In order to prevent the dirt, straw, etc., which usually adheres to the ice, from passing into the freezing chamber a piece of coarse wire netting should be bent into the form of a hollow cylinder six inches long and four in diameter. The cylinder should then be stuffed with excelsior, and one end of a piece of glass tubing pushed into the center of the mass; the free end of the tube should then be connected with the faucet on the inside of the pail by a short rubber tube. The brine is then forced to filter through the tightly packed excelsior before entering the tube.

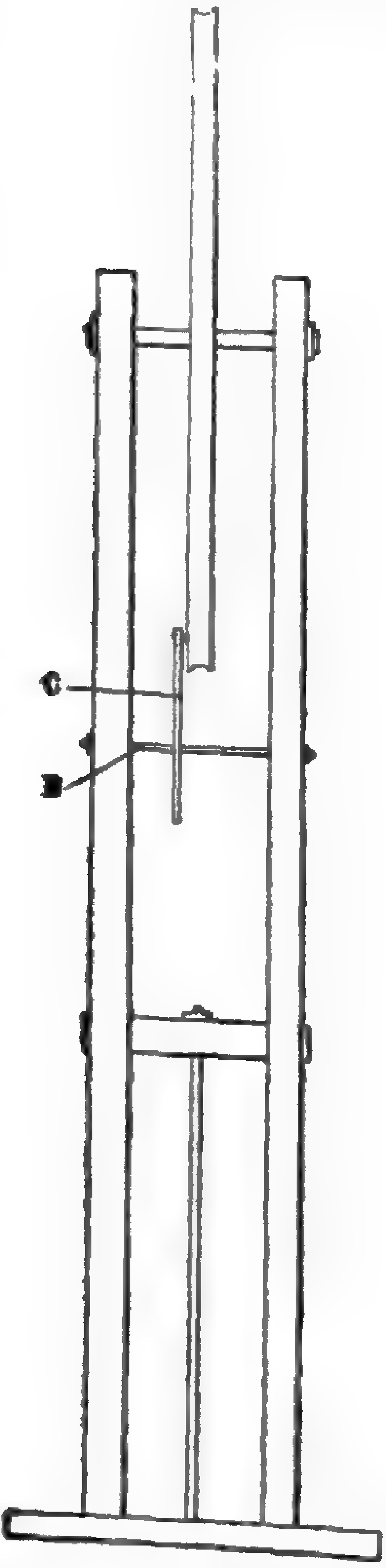

FIG. 2.

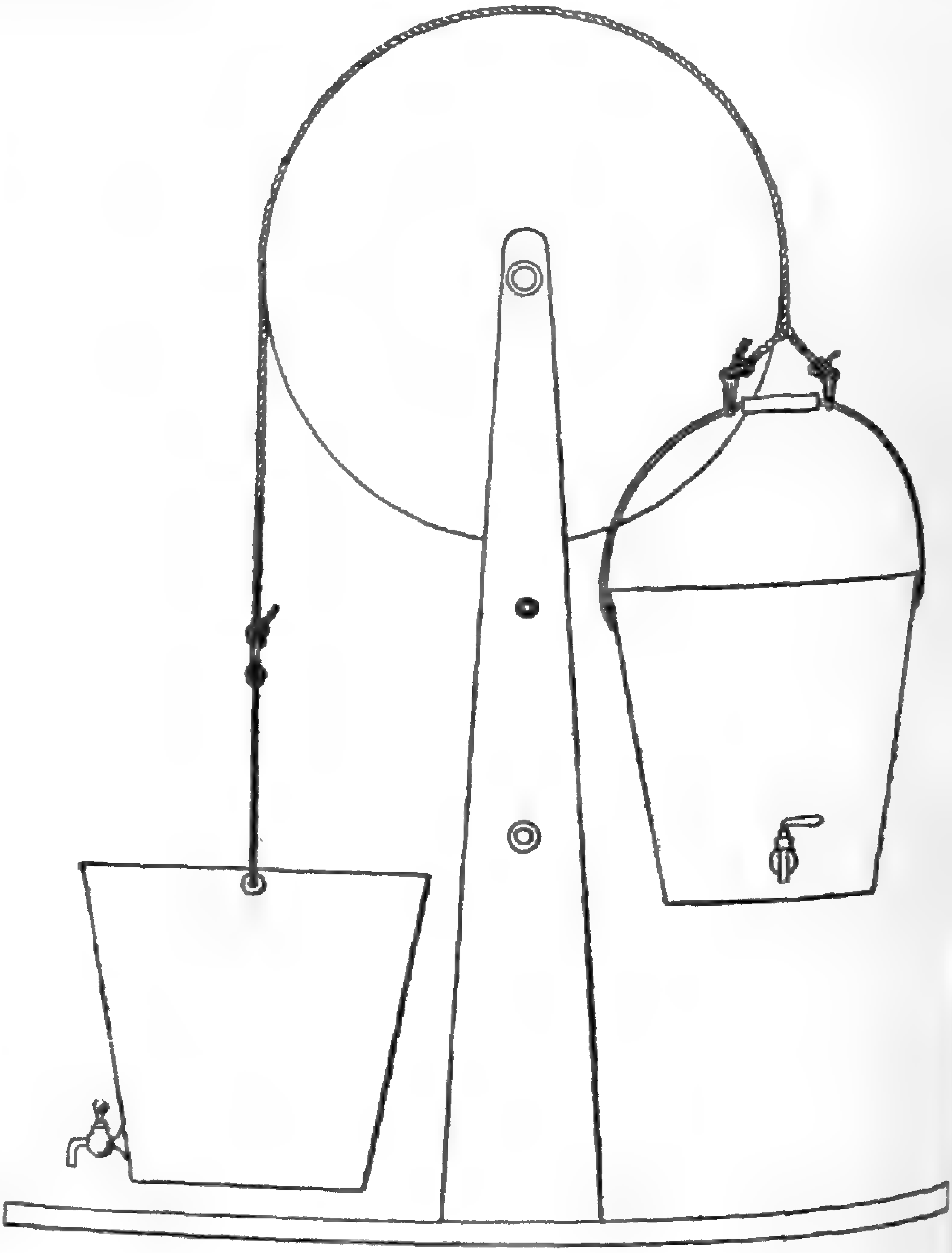

FIG. 3.

The standard upon which the pails hang is constructed of wood. It can best be understood by a reference to figures 2 and 3. Both figures are one-twelfth actual size. Figure 3 shows a side view of the standard. The diameter of the wooden wheel must be great enough to prevent the pails from striking the upright piece as they rise and fall. The rope which passes over the wheel is secured at its middle point by a nail driven through it into the wheel; the pails are fastened to the rope by ordinary metal "snaps," so that they can be instantly detached or put on. The rope should be of such length that when the bottom of one pail is about level with the top of the other the bottom of the latter hangs an inch and one-half above the base of the standard.

The construction of the upright piece is evident from figure 2, which shows an end view of the apparatus. The two upright pieces are held together by a wooden cross-piece, from which a stout metal rod runs to the base; the axle of the wheel also aids in holding the two pieces together.

An automatic catch serves to retain the pails in the position shown in figure 3. Figures 4 and 5 show this contrivance in flat view, one-half actual size. It is made of sheet iron, one-quarter of an inch in thickness. The small hole at the top is for the screw which fastens it to the wheel. It has a single continuous slot, *D*, in which are two notches, *F* and *F*; the outlines of the slot and notches are dotted in the figures. A thin strip of copper, one inch wider than the sheet-iron strip, is placed upon the latter, and its edges bent around the iron strip so as to partially surround it. It is thus able to slide freely upon the iron strip, but it should not fit loosely enough to slide of its own weight when in an upright position. The copper strip, which is shaded in the figures, has a slot, *E*, which in its narrowest part has the same diameter as *D*, over which it fits exactly.

The metal rod *B* (see fig. 2) is made to pass through the middle of both uprights and through the slots *D* and *E*, in which it must be small enough to slide freely. The strip *C* is then secured to the wheel by a screw passing through the hole at the top. The screw should be small enough to permit the strip to swing freely. The strip is fastened to the wheel in such a way that when the wheel is turned so as to bring both pails on a level, the strip is vertical. It should be fixed

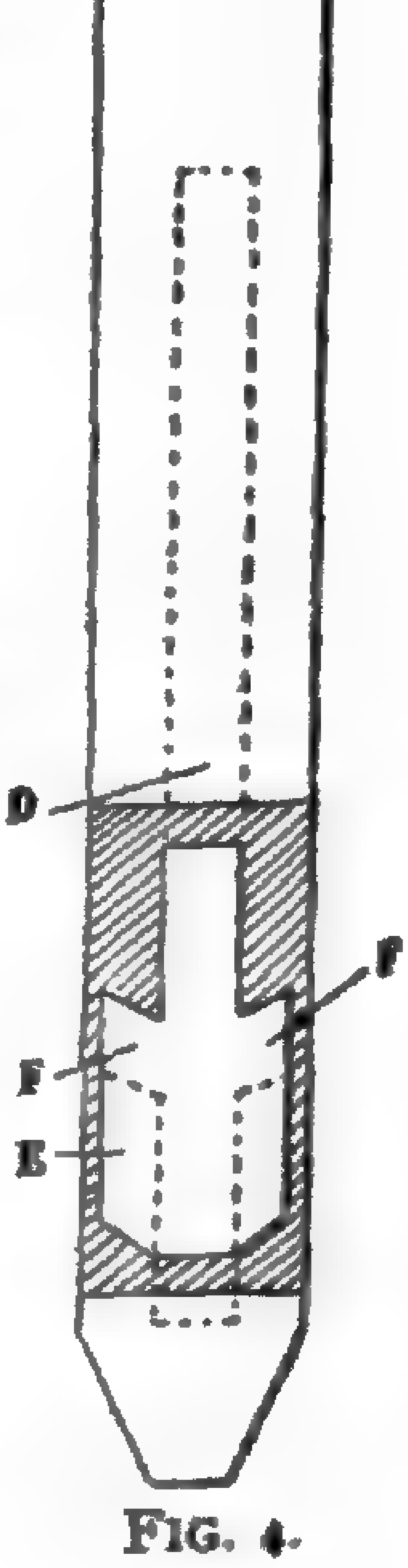

FIG. 4.

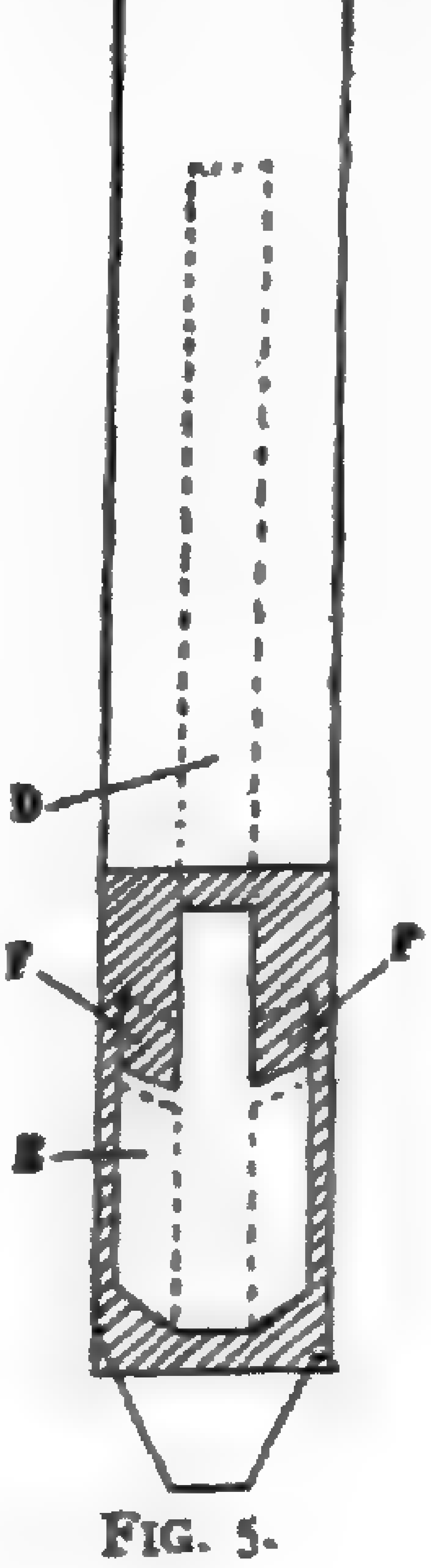

FIG. 5.

at such a height that when the pails are in the position shown in fig. 1, the metal rod, *B*, slips into the notch *F*, (fig. 4).

The weight of the upper pail (which is the heavier when the apparatus is in use) retains the rod in this position. The copper strip now has the position shown in figure 4. As the brine flows from the upper pail into the lower, the latter (which hangs one and one-half inches from the base of the standard), becomes the heavier and settles slowly down till it rests on the base. This causes the wheel to turn and the rod *B* (fig. 2) travels to the bottom of the slot *D* (fig. 5) carrying with it the copper strip, which takes up the position shown in fig. 5. When all the brine has passed into the lower pail the latter should be raised. As the pail raises the wheel turns and the rod *B* travels upward in the slot *D*, but passes over the notch *F*, which is now covered by the copper strip. It continues to travel upward, carrying the copper strip with it until the iron strip *C* reaches a vertical position. As the wheel continues to turn the rod *B* begins to descend in the slot *D* until it again drops into the notch *F*. As the heavier pail is now uppermost it must remain so until the lower pail becomes heavier, when the process is repeated. This very simple piece of apparatus answers its purpose perfectly, is easily made and cannot get out of order.

In order to use the apparatus both pails are filled with cracked ice and coarse salt in alternating layers, the cylinder containing excelsior resting on the bottom of the pail.

The freezing chamber is clamped into the jaws of the microtome which touch only the wooden plug. Care should be taken that the metal part of the chamber does not touch the microtome as otherwise heat will be conducted to the freezing chamber and freezing will be more difficult. The standard is then placed on the table at the left of the microtome, with the end facing the front of the table. The pails are then attached and made to assume the position shown in figure 3. The tubes of the freezing chamber should project at the left and be connected, one with each faucet by rubber tubing. A cold brine soon forms which flows through the freezing chamber and almost instantly freezes the material placed on the top of the chamber. By means of the faucets the flow of brine may be regulated, and this in turn regulates the temperature of the chamber.

As soon as the brine has all run into the lower pail the position of the two pails should be reversed. The person using the microtome does not need to rise from his chair to accomplish this, since he can easily reach the pail nearest him and raise or lower it as necessity requires. The weight to be lifted is simply the weight of the brine, since the weights of the two pails with their content of ice and salt balance each other. The shifting of the pails therefore occupies only the left hand, leaving the right free. The falling of the lower pail indicates that most of the brine has run through. If a more accurate indication is needed one may insert in one of the rubber tubes a glass T-tube with a cork at the top of the free arm of the tube. A black feather may be fixed to the cork in such a way that the end dips in the current and shows by its deflection the direction and force of the flow. When too much brine has accumulated the temperature rises and freezing proceeds too slowly; a part must then be siphoned off. Usually this happens once, or at most twice, during the course of one day's use of the apparatus. The addition of more ice is very seldom necessary.

If the operation of freezing is interrupted for less than half or three-quarters of an hour the faucets should be nearly closed. Objects already frozen will remain so under these conditions as long as the brine continues to flow. If the apparatus is to be left for a longer time the brine should all be drawn off and thrown away, and the faucets closed. A moment's flow will render the apparatus ready for use again.

During a year's test in cutting both plant and animal tissues this apparatus has proven entirely satisfactory. Its principal advantages are as follows:

1. It is simple, inexpensive and cannot get out of order.

2. The material cannot alternately thaw and freeze (as is the case when it is frozen by the ether or carbonic-acid-gas method), but remains at a constant temperature and of uniform consistency.

3. The danger of over-freezing, which has proved a serious defect in the carbonic-acid-gas method, is entirely obviated. On the other hand, no difficulty is experienced in freezing, as is often the case with the ether method.

4. It can be applied to any microtome which has a horizontal movement of knife or object carrier. In most cases no previous embedding is necessary but fresh material, or that which is preserved in aqueous media, may be placed in a syrupy

solution of gum arabic[1] and frozen at once. Tissues sectioned in this way are practically unaltered. Delicate tissues and those containing large air cavities can be sectioned with the greatest ease. The damage wrought in many tissues by dehydration are entirely obviated by the freezing method.

Frozen sections may be mounted in glycerin jelly or any aqueous medium. If mounted in glycerin, it will be found convenient to ring the cover with a thick solution of gum arabic. A glycerin-gum is then formed around the edge of the cover and in a short time is dry and hard on the outside. A ring of Canada balsam or cement may then be applied and the mount is as permanent as it is possible to make a glycerin mount. Frozen sections may be fixed to the slide for staining purposes by Fol's method (see Lee; Microtomist's Vade-Mecum, 218, 1893).

When delicate parts are present, such as spores, etc., which are apt to fall out of the section, the following method can be used with entire success.

A gelatin solution is made as follows: The best gold label gelatin is selected and carefully brushed clean and made up according to the following formula: gelatin, 32 parts; distilled water, 48 parts; carbolic acid, 1 part. Dissolve the gelatin in a closed vessel over a water bath; add the carbolic acid and mix until it is thoroughly dissolved, and then add the white of one egg to clarify.[2]

The object to be cut is placed for a short time in the melted gelatin and quickly washed in warm water (about 90° Fahr.) to remove the gelatin from the outside. It is then placed at once in water at room temperature. This sets the gelatin with which the object is now infiltrated, and the latter may be sectioned at once in gum arabic or preserved in two per cent. formalin until needed. If sections cut in this way are placed on a slide and a little glycerin added over a water bath, a glycerin jelly is formed and the addition of a cover and a ring of cement completes the process. If the sections are taken from the knife in the gum in which they are cut and placed at once on the slide and subjected to the process just mentioned, a glycerin-jelly-gum is formed which makes an excellent mounting medium.

A simpler form of the above apparatus is shown in figure

[1] As some of the preservatives ordinarily added to gum arabic attack the knife, formalin is recommended for this purpose.

[2] For this formula I am indebted to Mr. N. N. Mason of Providence, R. I.

6.[8] The larger pail is filled with ice and salt and the smaller one catches the brine which is poured back into the larger pail. A stop-cock at the lower pail regulates the flow; the former is fastened to the pail by a wooden clothes pin.

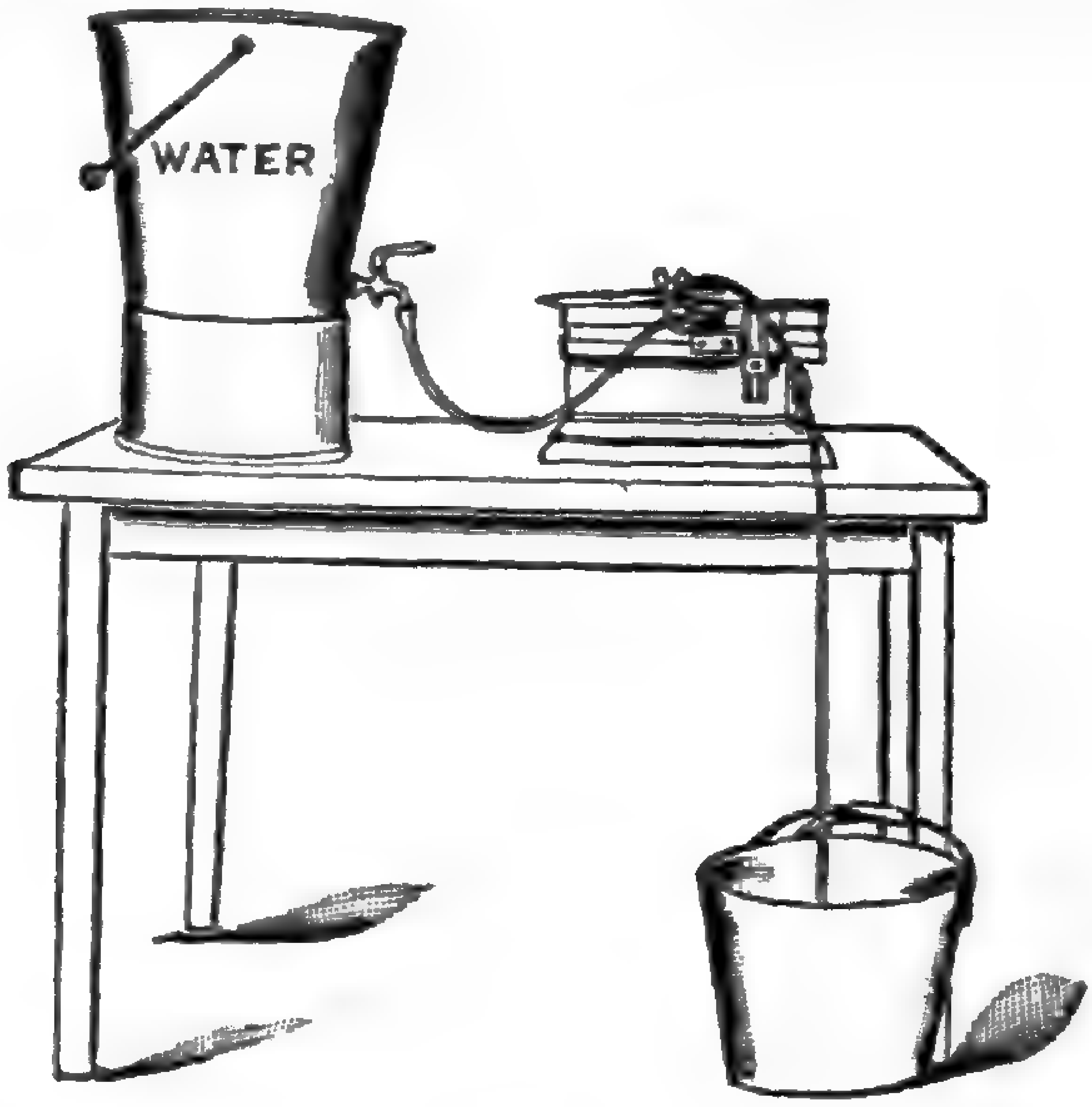

FIG. 6.

An inexpensive substitute for this form of the apparatus may be quickly made. A large wooden pail may be bored near the bottom, a cork inserted and pierced by a glass tube. A piece of brass pipe, one inch in diameter, with a thread at the end may be sawed off an inch and a half from the end and converted into a freezing chamber by soldering in the brass discs and inserting two straight tubes at the side. A glass tube drawn to the required aperture may be used in the place of the stop-cock at the lower pail and other tubes of different apertures may be quickly substituted.

Providence, R. I.

[8]For the use of this cut I am indebted to the courtesy of the Bausch & Lomb Optical Co., Rochester, N. Y.

Notes on some North American species of Parmelia.

HENRY WILLEY.

The large lichen genus Parmelia presents many difficulties from the variability of its forms, and with regard to the chemical reactions of the thallus with liquid potassa (K) and hypochlorite of lime (CaCl) either separately or combined. As Tuckerman has remarked, it tends to develop into evernioid forms, of which the extreme is manifested in P. Kamtschadalis and P. cervicornis, and this tendency is manifested in species of the stock of P. perforata. Some writers have placed Evernia furfuracea in Parmelia. As to the chemical relations I am unable to attach absolute specific value to them. There are exceptions to their constancy, some of which were pointed out by Tuckerman in a paper in the *American Naturalist* for 1868, which remain to be accounted for. I have recently collected two specimens of Parmelia on the same trunk, one of which gave a positive (red) reaction with K, and the other a negative one, while otherwise there was not the slightest difference between them. So I have collected at the same time on red maple, two specimens of Buellia parasema in one of which the thallus gave a yellow reaction with K, while in the other the yellow immediately turned to red. But all the difference between them was that the former seemed to be the younger of the two. Specimens gathered at other times yielded no reaction. The cladonias also present similar difficulties. It is possible that a lichen may possess different chemical constituents at different stages of growth, or under different conditions of soil, climate, etc. Experiment on the same plant at different periods of its development is necessary to confirm the deductions from simple examination. Still, the reactions appear to be constant in most of the species of Parmelia and may serve as an aid in their determination, while the exceptions remain to be accounted for. Where there appears to be an exception we may best say that "perhaps" the specimen belongs to a distinct species.

Tuckerman, whose views in regard to species were very conservative, described in his *Synopsis* nineteen species of Parmelia. Some of his varieties are regarded by other authors, either on chemical or other grounds, as distinct species. Nylander[1] described ten North American species, and has discovered some new ones among specimens sent him from New Bedford; and some additional species have turned up since Tuckerman wrote. So that at present there appear to be known about forty species. The reactions of most of the species are given in Hue's *Lichenes Exotici.*

1. P. PERLATA (L.) Ach.—Th. K yellow Me. K—. But in the var. *olivetorum* Ach. (the proper designation of which seems to be *olivaria* Ach.) Me. K dull red. The lichen is a widely extended one. Very near to it is *P. cetrarioides* (Del.) Nyl., which occurs on rocks in New Bedford, agreeing with a specimen from Switzerland (Lojka.). Another New Bedford specimen, with the habit and reaction of perlata, has the lobes ciliate, and may be the var. *ciliata* DC. But Nylander[2] considered it hardly to differ from *P. crinita.* A sorediate form (var. *sorediata* Schær.) also occurs in New Bedford.

2. P. CRINITA Ach.—The New Bedford plant referred here in Willey's *Lichens of New Bedford* is referred by Nylander to *P. perforata.* But I have since found an isidiose specimen, otherwise resembling *P. perlata*, which may be the plant of Acharius and of Tuckerman's *Synopsis* which is so described. The reactions of P. crinita are variously described by authors as Me., "saftgrün" (Krempelhuber), "atro-virens fere atra" (ibid.). The *P. crinita* Nyl. Syn. seems to be a different plant, and is referred by Wainio (Brazil) partly to *P. proboscidea* Tayl. and partly to *P. melanothrix* (Mont.). P. crinita is mentioned in several lists of North American lichens, but on what authority I know not.

3. P. CETRATA Ach.—This, like the preceding, is a difficult lichen. Tuckerman seems to have regarded all forms of the stock of perforata with narrowed or finally evernioid lobes as belonging here. But I think this can hardly be the case. *P. perforata* var. *cetrata* from Australia (Müller) gives Me. K—. A remarkable variety is var. *hypotropoides* Nyl. in litt., growing on branches of red cedar at New Bedford, with the thallus underneath white, as in *P. hypotropa*, and becoming yellow with K. Wainio (Brazil) gives the reaction of cetrata Th. K yellow, Me. K yellow, then red, with which the New Bedford plant agrees. A large New Bedford plant called *P. cetrata* by Tuckerman, is referred by Nylander to *P. tiliacea*, of which

[1] Flora —: 605 *et seq.* 1885.
[2] Flora —: 603. 1885.

it has the lobation, but much larger spores, while it agrees with tiliacea in its closely appressed habit. The plants called cetrata in lists of North American lichens must be considered as doubtful.

4. P. TINCTORUM Despr., Nyl. Pyr. Or. 16.—This plant, according to Wainio, Brazil, has received various names and is *P. perlata* var. *coralloidea* Mey. & Flot., *P. praetervisa* Müller and *P. perlata* var. *platyloba* ibid: to which he unnecessarily adds another, *P. coralloidea.* A specimen from Jamaica (Rev. F. Wolle) determined by Nylander has the thallus prolonged into convolute lobes; and a specimen from the west coast, H. A. Green, resembles var. *platyloba.* All the specimens give the same reaction Me. CaCl red.

5. P. SACCATILOBA Tayl. Nyl. Flora —: 608. 1885. Pyr. Or. 40. (*P. latissima* Kph.; *P. Zollingeri* Hepp.)—Me. K yellow, CaCl light red. Spores large, nearly as in *P. latissima* Fée.—Mexico. *P. glaberrima* Kph. is *P. latissima* Fée.

6. P. COMPARATA Nyl. Flora—:290. 1869 where it is said to be perhaps a var. of perlata analogous to cetrata, with the aspect of laevigata, is said in Hue Exot. to be widely distributed in North America. Me. K yellow.

7. P. SUBMARGINALIS Mich. Nyl. Flora —: 607. 1885.—(*P. perlata* Mont. Cub. 230; *P. perforata* var. *cetrata* Müller Beitr. *n. 69; P. perlata* var. *ciliata* ibid. *n. 1639*). "Similar to *P. perlata*, but the margin of the thallus ciliate and often partly laciniate, or laciniose-fimbriate. Apothecia larger, often perforate. Spores .014–018 × .008–.012^{mm}." Nyl. l. c. Me. K— . In a New Bedford specimen the thallus is divided into long, narrow, convex laciniæ, which are black and naked beneath. Another old and rigid specimen was called *P. subrugata* in Willey: Lichens of New Bedford, but the prolonged lobes are broader.—In *P. perlata* the spermatia are bifusiform, .005^{mm} long; in *P. submarginalis*, acicular .008-.010^{mm} long, and in *P. perforata* acicular-cylindrical, .010-.016^{mm} long.

8. P. HYPOTROPA Nyl.—This species is distinguished by the white borders of the under side of the thallus, which are colored yellow then red by K. Reaction as in *P. perforata*, Me. K yellow, then red.

9. P. HYPOTROPOIDES Nyl. in litt.—Thallus expanded, membranaceous, glaucescent, the rounded lobes depressed, more or less crenate, and finally elongated into narrow flat

laciniæ, beneath black and naked, but yellowish-white at the margin. Me. K red, but not showing any reaction beneath. Apothecia large, perforate. Spores .009–.16 × .006–.009^{mm}.—On trees, New Bedford, and District of Columbia (Lehnert).

10. P. PRÆSIGNIS Nyl. Pyr. Or. 17; Flora —: 610. 1895. On trees, Arizona, Pringle, 1881. Me. CaCl red. Spores .014—.016 × .007—.009^{mm}; spermatia bifusiform, .006—.007^{mm} long. Also in Mexico.

11. P. TILIACEA Ach.—The reaction given is Me. CaCl red, as in Lojka Exsic. Univ. *n. 62.* But only one of numerous specimens gives any reaction, which would be *P. sublævigata* Nyl. Me. K yellow, then red.—*P. livida* Tayl. from New Orleans is considered by Nylander as a variety of this; but Müller in Beitr. *n. 1344* looks upon it as distinct. *P. galbina* Ach. Syn. 195, from North America is a small form on dead wood. *P. relicina* Fr., which is made a variety of this by Tuckerman, is considered by most authors to be distinct.

11. P. BORRERI, var. RUDECTA Tuck. is separated by Nylander on account of the spermatia which in Borreri are sublageniform and in rudecta acicular-cylindrical and twice as long.

12. P. KAMTSCHADALIS (Ach.) Eschw. Me. K red.—"*Borrera glabrata* Schwein." then "*Evernia polita* Tuck." in herb. Schwein. (comm. Eckfeldt without station) seems to be a broad-lobed form of this.

13. P. CONSPERSA (Ehrh.) Ach.—Me. K yellow then red. But isidiose specimens on rocks, New Bedford, give Me. K—. as is also the case with a similar specimen in Stenh's Exs. Suec. *n. 122*, while the others give K red.

14. P. MOLLIUSCULA Ach.—Me. K yellow, then red. Mr. T. A Williams has described and figured in Report of Missouri Bot. Garden, May 1892, a fertile specimen collected in the Black Hills by Dr. Engelmann in 1856. A fertile plant, collected by T. S. Brandegee in Colorado, closely resembles Mr. Williams's figure and description. Apothecia numerous, the margin incurved, crenate, the disk blackening. Spores .011–.013 × .005–.006^{mm}. Spermatia cylindrical, .007–.009^{mm} long. Me. K red.

15. P. CONGRUENS Ach.—This species, which is figured in Swartz, Lichenes Americani, *pl. 4*, was not recognized by Tuckerman as North American. But according to Nylander it occurs in Mexico, and Müller, who had seen Muhlenberg's

original specimen in herb. Swartz says in Lich. Argent. 64 that he cannot distinguish it from his *P. versicolor* Beitr. *n. 315*, from New Holland, and refers Krempelhuber's plant to a distinct species, *P. subcongruens*.

16. P. ISIDIOCERA Nyl. Syn. **1**: 382.—This occurs in arctic America. "Affinis *P. aurulenta*."

17. P. SPHÆROSPORELLA Müller Beitr. *n. 1650*.—Thallus appressed ochroleucous, rugose beneath, pale yellowish, and with pale fibrils. Apothecia at length plane, the disk from flesh-colored becoming livid-fuscous. Spores globose, diam. .005–.007^{mm}.—On trees, Oregon, Dr. Lyall, in herb. Kew.

18. P. ACETABULUM, Me. K yellow then red, occurs in arctic America. Most of the Parmelias of the brown series give no reaction.

New Bedford, Mass.

Remarks upon Paleohillia, a problematic fossil plant.

THEO. HOLM.

WITH PLATE XVII.

This genus has lately been established by Mr. F. H. Knowlton, and the description has been published in the *Bulletin* of the Torrey Botanical Club.[1]

It is always interesting to learn something about the structure of fossil plants, especially since their manner of preservation very often renders their microscopical examination exceedingly difficult. But even when the preservation permits a closer examination, so that the tissues may be easily observed, we then meet with the difficulty of parallelizing the structure with that of the plants known. It then depends upon the investigator himself whether he is able to point out anatomical characteristics which are sufficient for the classification of the plant in question. If no such conclusion can be reached and especially if we can not even ascertain the character of the fragment, whether it be a stem, a leaf, or a root, we do not feel justified in giving any further record of the specimen, except stating the fact that plants have occurred in the stratum, where the relics were found. We, therefore, do not think it advisable to establish anything like a family or a genus upon such defective fragments, and we take the opportunity to discuss the question in a rather general but comparative way.

The genus *Paleohillia* has been established upon some fragments, said to be hollow stems, the diameter of which is from 5 to 7.5^{cm}, the length of the specimens being several centimeters. The epidermis is described as consisting of elongated and shorter more irregular cells, and the stomata are said to have from four to six guard-cells. The accompanying plate shows a part of Mr. Knowlton's figure (fig. 1) of the epidermis, and we have, also, copied his drawing of a stoma (fig. 2), magnified 300 times.

The first question is now to decide whether the epidermis shows anything so characteristic as to enable us to determine whether the fragment really represents a stem. Considered

[1] **22**: 387–90. 1895.

by themselves the epidermis cells do not give us any hint in this direction, except that they seem to differ from those of an ordinary root. The fact that the cells are different in size and shape, viz., that there are bands of elongated cells in alternation with other bands of shorter, more irregular ones, only indicates that the elongated cells may have been situated above some fibro-vascular bundles. This is a very general feature of the mono- and dicotyledonous plants, and such structure is also known from the cryptogams. But whether it is a stem or a leaf can not yet be made out.

The next question is as to the nature of the stomata. Mr. Knowlton states that "these are the most remarkable feature of the plant, because the guardian-cells [*sic*] are quite irregular in shape and appear to vary in number from four to six." It is true that the number of guard-cells about a stoma is not always limited to two, and that the stomata of Equisetum and Marchantia have more. But as such stomata are entirely different from those figured by Mr. Knowlton, we have copied an illustration of the epidermis with stomata of Marchantia (fig. 5), taken from Sachs.[2]

Mr. Knowlton also states that the "guardian-cells are of course below the epidermal-cells." Combining now the facts in the structure of the stoma of Paleohillia we have seen that the number of guard-cells is not constant and that the stoma is situated below the epidermis. We will compare this description with Mr. Knowlton's drawing (fig. 2) and with our figure 6, which we have copied from Van Tieghem.[3] Our copy shows only a part of the original illustration so as to give the aspect of the stomata of *Nerium Oleander*. The stomata (*S* in the figure) are in this plant situated in cavities (cryptes stomatifères) below the surface of the leaf, and surrounded by the pneumatic tissue. But we fail to find any resemblance between these two figures, and we begin to doubt that Mr. Knowlton really has observed any true stomata.

We will return to his first figure (fig. 1) and consider again the openings, which should contain the stomata. We see then some roundish openings (if not cells?), which are surrounded by four or six cells, a structure that is very familiar

[2]Sachs, Julius: Vorlesungen über Pflanzen-Physiologie 83. *fig. 65 D.* Leipzig 1882.

[3]Van Tieghem, Ph.: Traité de Botanique 60. *fig. 33.* Paris. 1884.

to us. Cells of that shape and arranged in that manner remind us much of the basal cells of many vegetable hairs, and the resemblance is, indeed, very striking. We have examined a number of hairy plants, and found exactly the same structure. Fig. 3 is for instance the epidermis of a dead stem of the common garden pelargonium, where the hairs have dropped, leaving only the basal cells, which are, however, sufficient to indicate their place. Our next figure (fig. 4) represents also the epidermis of the same plant, but this has been taken from a living stem with the glandular hairs still attached, one of which has been figured. The aspect of this epidermis with the varying number of cells surrounding the base of the hairs does not seem to differ in any respect from the figure of Paleohillia given by Mr. Knowlton. And if we now add that bands of elongated cells are also observable in Pelargonium, we feel justified to state that the epidermis itself does not give any characteristic whatever so as to lead us to any conclusion.

What we have shown to be the epidermal structure of Pelargonium agrees, also, with the stem and leaf of many other plants of widely different families, so that there is no marked characteristic in the epidermis of Paleohillia. The fragments of this plant may just as well represent a closed sheath or a terete leaf as a stem, and so far the material seems too poor for the establishment of a new genus with "anomalous structure."

Washington, D. C., October, 1895.

Explanation of Plate XVII.

Fig. 1. Epidermis of Paleohillia.—Fig. 2. Stoma of same.—Fig. 3. Epidermis of a dead stem of Pelargonium. × 500.—Fig. 4. Epidermis of a living stem of same. × 500.—Fig. 5. Epidermis of Marchantia. —Fig. 6. Epidermis of Nerium Oleander, transverse section.

Notes from my herbarium. V.

WALTER DEANE.

My seedling collection.

As the spring of 1895 opened and the first delicate green began to appear, I found myself considering how I should add to my herbarium. All the plants that I might collect in the vicinity of Cambridge were already represented in my collection in flower, fruit, root and seed, and it seemed at first as if I must wait till the summer vacation might give me an opportunity of visiting some fresh locality. I was strolling one day over a bit of waste land, watching the little plants pushing their tiny heads above the ground, and thinking how impossible it was for me to name a single one of them in that early stage of their growth, when suddenly it occurred to me to make a collection of seedlings. Why shouldn't they have a place and an important place, too, in an herbarium? They are the beginning, the promise of the future plant, and yet we pass them by and refuse to recognize them. Then it would be interesting to compare these early forms with the full-grown plants and to see how the leaves in the two cases resembled each other. So I decided then and there to make a collection of as many seedlings as I could. This I did, and during the months of May, June and July I was engaged in as fascinating a piece of work as I have ever done in a botanical way.

My principal collecting grounds in Cambridge were of three kinds, waste land such as produces the ordinary garden weeds, a bit of bog frequented only by the botanist, and a salt marsh. My baby press and collecting box were constant companions and they never did better service. When I found a patch of seedlings, I collected a number of them carefully, and if they were small enough, as was generally the case, they went right into the little press. I then marked the spot in some way for future visits, and in the case of some species I made as many as half a dozen trips to the same patch, taking away specimens each time, for I wanted the collection to show the species from the seedling to the full grown plant, or at least to an identifiable form, all collected from the same spot. Sometimes the little fellows would betray their names very soon, and again I would wonder and wonder before I could compel the reluctant plant to reveal itself. Patience, however, always brought its reward.

There are difficulties, nevertheless, that are sometimes insuperable. A drought may dry up the precious spot after weeks of careful watching. In one instance I watered constantly a patch of weeds which I was afraid would not reach maturity, and I was rewarded with fine specimens. Cattle may crop the cherished plants just as you are expecting good returns for your care. I had collected seedlings of a Polygonum. The plants were advanced enough to show that they were either *Polygonum Convolvulus* L., the black bindweed, or *P. dumetorum* L., var. *scandens* Gray, the climbing false buckwheat. I wanted to see the calyx lobes, but when I visited the spot at the right time for fruit, the plants were all eaten down by cows. The weeds, however, were persistent, and later recovered entirely and told me the story of their name. It was the latter species. These instances are enough to show what may happen to disappoint the seedling hunter. Of course the cultivating of seedlings would obviate all this trouble, but I wanted the plants from their own native habitat. That gave additional zest and exercise.

One plant kept me guessing for some time. Near the banks of Charles river by a salt marsh there was a large patch of the most beautiful green. I found it to be composed of myriads of seedlings not more than half an inch in height. What were they? The small linear cotyledons told me no story. I felt all the enthusiasm of a beginner analyzing a new flower. As the little plants grew, I narrowed my guesses, till a premature blossom on a specimen not much over an inch high, told me it was *Buda marina* Dumort., the salt sand-spurrey, common enough to us all in its full dress. I shall always know it hereafter in its baby clothes. Its cotyledons much resemble, in miniature, the later leaves.

The limits of this paper will not allow a discussion of all or nearly all my seedlings, for during these delightful three months I collected between fifty and sixty species. Mention of a few may, however, be of interest. In Falmouth, Mass., early in July I found at the head of the beach in the clear sand, seedlings of some interesting species of coast plants. I was particularly attracted to *Lathyrus maritimus* Bigelow, the beach pea, an account of whose long rootstocks I wrote in the first paper of this series. The old plants were a foot high and in flower, while scattered about among them were small plants an inch or so above the sand. I found that these were of two kinds, readily distinguishable after a short examination, namely, seedlings and young shoots from old rootstocks. I made collections of both. In almost every case the pea was attached to the seedling and it was always from two to four inches below the surface of the sand. How does the pea invariably reach that depth where the necessary moisture is always present? The constant fall winds which blow over the evershifting sands partially account for that. And yet, in the case of the little seedlings of *Euphorbia polygonifolia* L., the spurge, and *Atriplex arenarium* Nutt., the orach, as well as *Solidago sempervirens* L., the seaside goldenrod, and others which I collected in quantity, the size and position of the plants show that their seeds lay much nearer the surface of the sand, though subjected to the same conditions as those of the beach pea. In seedlings of *Xanthium Canadense* Mill., var. *echinatum* Gray, the cockle burr, the burr enclosing the akenes is buried to the same depth as that of the beach pea. This question of the distance below the surface attained by different seeds is worthy of examination. The roots of the pea seedlings, of which I examined a large number, were delicate and very white, and penetrated the moist sand for four inches below the pea. In one instance I dug up a whole pod still containing a single pea which had sprouted and sent its seedling above the sand. The pod was soft and moist, and would soon have decayed.

In Whitefield, N. H., in the rich northern woods, I made some valuable additions to my collection. It was much harder to find the seedlings in the luxuriant growth that carpets the floor of those grand forests of birch, ash, spruce, pine and maple. In the deep shade half hidden amongst the low growth that covered the ground, were seedlings innumerable even in the latter half of July. I found in abundance all forms of three of the northern maples, *Acer Pennsylvanicum* L., the striped maple, or moose-wood, *A. spicatum* Lam., the mountain maple, and *A. rubrum* L., the red or swamp maple.

In *Acer Pennsylvanicum* L., the cotyledons are from one-half to three-fourths of an inch long and narrowly obovate in shape. The first pair of leaves are ovate, heart-shaped, taper-pointed and doubly toothed, but with no suggestion of the three lobes so characteristic of the typically developed leaf. This primitive form occurs at times even in the sixth pair of leaves, while again in the second pair the lobing becomes manifest. I have one specimen in which the third pair of leaves are very typical, while the fourth pair on the same plant have lost their lobes. This is significant when we compare the seedlings with the old plant, for in the latter case the shape of the leaves varies very much, the same tree producing every form from the typical leaf to one resembling in every detail but size the first pair of leaves above the cotyledons.

In *Acer spicatum* Lam. the seedlings very nearly resemble those of the former closely related species, and there is the same gradation to the typical leaf. The coarse serration of the developed leaf is shown in the first leaves. The downy character of the under surface of the leaf does not, however, appear till the plant is pretty well developed. The leaves on the ends of new shoots in the old plants resemble in shape and size the first leaves of the seedlings. In *Acer rubrum* L. the cotyledons are broadly linear and the first leaves have clearly the whitish under surface peculiar to the type. In shape they behave much like the two former species.

One day I was hunting in the woods on my hands and knees for new plants, when I saw a seedling with oblong thick cotyledons some two inches long. The first pair of leaves had developed. They were simple, oval, acute, serrate, and I thought that I had found at last a young birch. Judge my surprise when, on carefully removing the plant from the black mould in which it was growing, I found still attached to the base the key of the black ash, *Fraxinus sambucifolia* Lam. My seedlings of this species as well as those of the white ash, *Fraxinus Americana* L., resemble almost exactly those figured in Sir John Lubbock's work on Seedlings. The leaves above the first pair soon begin to show signs of their compound character and are of very varied shapes. I have one small plant of several years' growth. It is nine inches high and bears but one pair of leaves, both simple. One is four and one-half inches long, the other three-eighths of an inch.

The woods in Whitefield were full of the yellow birch, *Betula lutea* Mx. f., and the little seedlings were very abundant. The cotyledons are orbicular in outline with short petioles, and the first leaves are ovate and coarsely toothed. I have a complete series of twenty-six specimens from the young seedling with fruit attached, through the varying forms to the leaves and bark of the old tree. Leaves of plants a foot high are much narrower than those of the developed form. On an old prostrate moss-grown log, I collected all forms of this birch, growing in a row as if awaiting the collector.

It was pretty delicate work mounting my seedlings. The choice lay between gum strips, gluing, and paper pockets. I decided to use the last two methods. I glued the plants in the usual way, picking them up one by one with nippers. The process was slow, but the results most excellent. Thirty specimens sometimes are on a single sheet. They are arranged in various symmetrical lines and graded according to age. Paper pockets contain extra specimens in many instances.

This short sketch of a few of my seedlings is perhaps enough to show that they should be well represented in our herbaria. Their germination has been studied by specialists in many cases, and why should we not be able to display them when we show the flowering and fruiting forms of the adult plant? And there are many other forms of our common species, besides the seedling and the old plant that should also be collected and made ready for study. There are those intermediate stages well illustrated in the early leaves of the water parsnip, *Sium cicutaefolium* Gmelin. These leaves show every gradation from the typical pinnate forms with serrate leaflets to the submersed leaves with the finest hair-like dissections. It is always the lowest leaves that show the greatest variation from the type. Sometimes these are very large, even from fifteen inches long to five inches broad. It is not always the submersed leaves that show this dissection, for I have collected specimens in Cambridge, growing entirely out of water, where the lower leaves are about intermediate between the two extremes. They are erect, while the submersed forms are extremely weak. Does not this show some connection between this species and the polymorphous *Sium Carsonii* Durand? These and many such questions must be answered by the specialist, and surely the interests of science will be furthered if our herbaria are well stocked with all these connecting forms from seed to seed.

Cambridge, Mass.

Note on calcareous algæ from Michigan.[1]

D. P. PENHALLOW.

In the latter part of the summer of 1891, Sir Wm. Dawson received from Mr. B. W. Thomas, of Chicago, some very curious and interesting calcareous pebbles formed by algæ. They were transferred to me with the request that I should report upon the nature of the organisms giving rise to them. These pebbles were found in considerable numbers in certain Michigan ponds by Dr. J. W. Velei, secretary of the Chicago Academy of Natural Sciences. The specimens were found on a smooth, sandy bottom, under about four feet of water, and the collector states that when fresh "they had so soft and slippery a feeling" that he thought they were alive. Those which reached me were said to be representative of the average size. They were found to be irregularly ellipsoidal with a thickness of about 40^{mm} and a diameter of about 60×80^{mm}. Light ashy gray, the surface was found chiefly smooth, but here and there with depressions of various sizes, frequently merging into actual cavities. The pebbles are not solid, but appear as a thickish shell-like mass surrounding an irregular cavity, such as might be conceived to arise from a progressive internal decay, concurrently with an extension of the mass from without.

Upon treating a portion of a pebble with acid to remove the incrustation of lime, it became evident that we had to deal not with an individual organism, but with a community possesessing considerable diversity of plant forms, while it was also evident that the growth of the mass had involved the inclusion of a variety of foreign bodies, some of which at least, might have served as a base for the algal growth.

From my notes taken at the time, it appears that owing to the imperfect condition of some of the plants, it was not possible to determine them conclusively in all cases. There were found, however, numerous diatoms, fragments of *Œdogonium*, *Gleocystis*, *Calothrix* and *Urococcus*, and in much larger quantity, plants of *Sirosiphon informe* Kg. Pine pollen and fragments of coniferous wood were also noted as com-

[1] I desire to acknowledge valuable suggestions by Dr. Farlow in the preparation of this note.

mon inclusions. The body of the specimen was found to consist of a plant which could not be satisfactorily determined. The material was therefore referred to Dr. Farlow, who not only confirmed the observations previously made, but ascertained that the dominant species was *Dicothrix gypsophila* (Ag.) B. & Flk. From the facts thus noted the inference was drawn that the pebbles might be regarded as veritable museums which would probably disclose some new form each time a fresh examination was made.

More recently some of these pebbles were sent to Mr. E. Grove, of England, who in turn transferred them to Mr. George Murray, of the British Museum. Mr. Grove undertook the determination of the diatoms, and has added considerably to our knowledge of the composition of these curious communal growths, by the publication of a list embracing 24 genera and 100 species and varieties.[2] This somewhat extensive diatomaceous flora is, nevertheless, hardly to be regarded as playing any special rôle in the formation of the pebbles beyond the fact of simple association, a relation which is readily understood when we recall the very universal distribution of these minute organisms, and the readiness with which they take up their abode in almost any situation.

The larger forms of plants found in the pebble were determined by Mr. Murray, who has given, in addition to other figures, excellent drawings showing the general external characteristics of the pebbles. His determination of the components showed that, "the predominating kind was clearly a species of *Schizothrix* while mixed with it there were other forms, notably filaments of *Stigonema* and *Dicothrix*."

Not arriving at a satisfactory conclusion respecting the first, Mr. Murray referred the matter to M. Gomont as final authority, who reported that, "the interior of the calcareous mass is formed of entangled filaments; they appear to belong to a *Schizothrix*, but which?" Finally he says, "I do not think one can make anything very distinctly out of this specimen except *Schizothrix fasciculata*, which undoubtedly occurs in abundance."[3] Excellent figures of this plant are given by Mr. Murray.

It would thus appear that from two independent sources we have results which, while agreeing in many respects, fail

[2] E. Grove.—Diatomaceous remains observed in preparations and washings of calcareous algæ. London. 1895.

[3] George Murray.—Calcareous pebbles formed by algæ. London. 1895.

to agree as to the character of the dominant plant, and the idea derived from the observations of Dr. Farlow and myself, that there is no element of constancy in the composition of the flora of these pebbles, beyond the fact that two or three species are in excess, would thus seem to be greatly strengthened.

Apart from the species found in the pebbles, but which could hardly have played any part in their original formation, it will be seen that there are present two and perhaps three species which, by their concurrent growth, may have produced them. It would be of great interest to know whether these large concretions are due to the growth of a single species, or, if to the combined growth of several species, the relative part which each plays. It is, therefore, to be hoped that some observer will watch the locality and obtain quite young material which alone will afford the means of settling this interesting question.

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Notes on Isoetes riparia and Isoetes saccharata.

T. CHALKLEY PALMER.

DISTRIBUTION.—In the middle states both these species are accounted quite local. Farther north *I. riparia* Engelm. is recorded as coming from several places, but south of New England it is apparently confined to the tidal shores of the Delaware river.[1] So far as known, *I. saccharata* Engelm. is still more restricted in its range; and, in fact, it had been, until quite lately, collected only by Wm. M. Canby, its discoverer, within quite circumscribed areas on the two neighboring Chesapeake rivers, Wicomico and Nanticoke, where it was first seen in 1863.

The writer has had the good fortune to find, during the last three years, in a number of coves and creeks about eighty miles farther north, a series of forms which, though departing in cases a good deal from the type, seem referable to *I. saccharata* Engelm., and to it only. These new stations are in Sassafras and Elk rivers, which are in effect broad, short arms of Chesapeake bay near its head, piercing the hilly "eastern shore" of Maryland.

The Back creek station, in Elk river, is within two miles of the Delaware and Chesapeake canal at its western end; and within perhaps seven miles of the eastern end of the same canal, on the Delaware river, grows *I. riparia*. Near relatives these two species have long been known to be. Now they are found to be near neighbors as well.

TYPE CHARACTERS.—Dr. Engelmann's descriptions have fixed these, and in order that the ensuing notes may not lack in clearness, they are here reproduced in full.[2]

I. saccharata Engelm.—A small plant, usually with a flat, depressed trunk; leaves subulate, olive green, spreading, ten to twenty in number, two to three inches long; sporangium spotted, oblong, with narrow velum; ligula triangular; macrospores 0.40 to 0.47^{mm} thick, covered with very minute distinct or sometimes a little confluent warts; microspores papillose, 0.024 to 0.028^{mm} long.

[1] Engelmann: Trans. St. Louis Acad. Sci. **4**: 382.
[2] Engelmann: loc. cit.

I. riparia Engelm.—A larger plant with slender but rather rigid deep green leaves (about fifteen to thirty in number) four to eight inches long, rarely longer; stomata numerous, dissepiments thick, consisting of about four layers of cells; sporangium mostly oblong, distinctly spotted by groups of brown sclerenchym cells, one-fourth or rarely one-third of it covered by the velum; macrospores among the largest, 0.45 to 0.65^{mm} in diam., marked with jagged crests isolated or anastomosing especially on the lower surface, which thus becomes somewhat reticulated; microspores more or less tuberculated, 0.028 to 0.032^{mm} long.

It is to be remarked that few hard and fast contrasts are established in the above descriptions. A difference of color, a larger size, a larger number of leaves are not such items as will help greatly to determine the allegiance of any doubtful plant in hand. Spore characters alone seem definite. (The relative *sizes* of the microspores are made a good deal of by Dr. Engelmann.) The sporangia of both are spotted, though a kind of distinction is for some reason attempted in Gray's Manual, 6th edition, where the sporangium of *I. saccharata* is stated to be "nearly unspotted."

Biologically, so far as known and studied, the two species have been thought quite similar.

VARIATIONS.—*I. riparia.* My acquaintance with this species, as it occurs on the Delaware near Chester, Pa., and immediately opposite on the New Jersey shore, extends over several years. It confines itself to clay-gravel tidal banks which are capped either with mud or fibrous growths that prevent the spores being washed away by the storm-tides. A large number of plants gathered in August, 1894, showed a majority with all mature leaves decidedly longer than the limit given. The usual, not the occasional, length was nine and three-fourths to ten inches. The color was dark green. The bulb or crown, when carefully measured, was found to be one-half to five-eighths of an inch in diameter. The sporangia were oblong, 4 to 5^{mm} long. The velum covered two-thirds to three-fourths of the sporangium, instead of but one-third. The macrospores were of the usual size, 0.50 to 0.63^{mm}, with the ridges quite jagged, and more or less reticulated. While gathering these plants I noticed many, only to reject them, which seemed to have lost their outer leaves, for they bore no macrosporangia. Only those plants were collected, the bulbs of which were obviously swollen with mature macrospores. The gathering was not studied closely until winter. So it comes that I cannot here give measurements of microspores; but in place of doing so, I have to announce that *I. riparia* is polygamous.

All the plants collected in August were found to bear mature macrospores all the way to the center. The whole gathering, minus a quantity pressed and sent away for exchanges, consisted of about twenty-five plants. It afforded not a single microsporangium. Only two or three immature leaves in the center of each plant were without spores of any kind. The number of leaves was as large as usual, and in some cases larger.

In August and September of 1895, in the same place, many plants were found with only two or three macrosporangia, others without any, and others with macrosporangia only. Six duplicates, remaining from a collection in 1890 (September) much smaller than the above, but still *I. riparia*, yielded but a single microsporangium, while macrospores, mature and immature, extended all the way to the center. Two plants collected at Pennsgrove, N. J., August 23, 1895, were likewise entirely female, though quite mature. These were of another outer aspect, but the spores showed them to be *I. riparia*. The leaves were of a dull green, five inches long, widely spreading. The crown measured five-eighths of an inch, the sporangium about 7^{mm}. Macrospores were 0.51 to 0.58^{mm} thick, irregular and distorted in shape, and covered with such a mass of crowded and crested ridges as to hide completely the surface proper. The rims of suture and the rim between the hemispheres were also jagged and quite remarkably high. The velum was broad, covering three-fourths of the sporangium. These plants approached some forms of *I. saccharata* in aspect.

Some smaller plants, collected in August, 1895, near Chester, rather darker green in color, were monoecious. The leaves are but four to four and one-half inches long, somewhat spreading; sporangium ovoid; velum quite narrow to one-third the sporangium; macrospores 0.38 to 0.47^{mm} and marked much as in some forms of *I. saccharata*. In fact, these spores, and those from some Chesapeake plants, do not admit of distinguishing descriptions.

The microspores of *I. riparia* vary, by actual measurement, from 0.026 to 0.030^{mm}. The "tubercles" with which they are beset are more plentiful, and so more obvious than the papillæ of the other species, but scarcely differ from them in appearance.

I. saccharata. The structural variation here is apparently greater than in the other species, while any dioecious tendency is still to be detected. Plants were collected at the original station on Wicomico river, Sept. 14, 1895, where they grow plentifully in sand deeply overlaid with mud. These agree, for the most part, with the description of Engelmann. But the leaves of mature plants are generally three to five inches long, and the macrospores 0.48 to 0.55^{mm} thick, with warts a good deal confluent, especially below, but not reticulated. The microspores measure 0.024 to 0.028^{mm} long. The olive green color, the rather flaccid state of the leaves, and the constant narrow velum were sufficiently noticeable. The whole plant, though taller than one would expect, is of quite slight build. The trunk is very small.

In 1895 I noted[3] the collection of this species in Elk river, at Piney creek cove and Back creek. In August of the same year it was observed in other places in the same river. As it appears there, it is a more robust plant than on the Wicomico. The leaves are somewhat stiffer, of a deeper green, and of a nearly uniform length of three to three and one-half inches. Though less flaccid, they are generally strongly curved, and their ends mostly rest upon the ground. The crown measures one-half to three-fourths inch in diameter; the macrospores are 0.40 to 0.48^{mm} thick, with warts but little confluent above, blunt and not at all crested. The microspores are 0.028 to 0.030^{mm} long, quite as long as those of *I. riparia*, but less plentifully knobbed than the latter. The velum varies but little, never reaching more than one-fourth the sporangium. The sporangium is sometimes 5^{mm} long, while that of the Wicomico plants is at most 3.5^{mm}. The trunk is not different from the typical trunk of the species.

On August 12, 1895, two more forms of the species, which further study may show to be worthy of distinction as varieties, were collected in Lloyd's creek, Sassafras river. The first of these, the most robust form of the species yet observed, has almost precisely the general aspect of the *I. riparia* collected at Pennsgrove, N. J., and described above. It

[3] Botanical Gazette, **20:** 32. Ja. 1895.

has stiffish, strongly curved leaves, rather dark green in color, 4 to 6 inches long. The crown measures one-half to one inch in diameter. The macrospores are 0.51 to 0.55^{mm} thick, marked with somewhat crested warts, higher and more confluent into twisted ridges than in the Wicomico plants. The microspores are 0.026 to 0.028^{mm} long. The velum is narrow. The sporangium is 6 to 7^{mm} in length, very long and slim. The microsporangium has much the same shape as in *I. Engelmanni* var. *valida.* This form was plentifully planted in rather coarse gravel, overlaid with a shallow mud.

Close beside, in densely compacted masses, grew the second form. The leaves are about the same darkish green, 8 to 9 inches long, and remarkable for the number and size of their stomata. These leaves spread less widely than in the form next preceding. The crown is about one-half inch in diameter. The macrospores are 0.51 to 0.53^{mm} thick, with warts quite crowded and confluent into twisted ridges below, sometimes a little reticulated; above, the ridges are somewhat parallel; and in general the markings may be said to differ markedly, in both these Lloyd's creek forms, from the type. Microspores are 0.024 to 0.032^{mm} long. The sporangia are about 7^{mm} long when longest. The velum is narrow.

In color, size of sporangium, and general outward aspect the two Lloyd's creek forms vary in a notable manner from the *Isoetes saccharata* type of Engelmann. This variation is in the direction of *I. riparia* as it presents itself in the plants collected at Pennsgrove, N. J. and above described. The macrospores are of an approximately equal size. But here the resemblance ends; for the macrospores of the Pennsgrove plants are, as stated, quite peculiarly deeply ridged, even for *I. riparia*; the velum is unusually broad; the habit is dioecious.

On the other hand, the small forms of *I. riparia* noted above, from Chester, Pa., vary in spore characters toward the Lloyd's creek plants, to such an extent that if such characters alone could settle the question, the two would have to be classed together. Yet here, as is the former case, the velum is often broader than in any known form of *I. saccharata.*

My study of these two species is as yet incomplete, and final conclusions as to their relations are scarcely permissible. The foregoing notes must make it evident that distinctive structural characters are less numerous even than would appear from Engelmann's account. Yet there appears to be an unmistakable specific distinction. The widely varying velum of *I. riparia* (from quite narrow to three-fourths the sporangium), and its spores differing so remarkably in size and markings, as well as the varying habit of growth and gradations of color; and the wide departures from the type in point of size, color and spore characters in *I. saccharata* may well cause doubt at times as to individual plants. But the narrow velum of the latter seems to be a constant feature, while in *I. riparia* it varies from leaf to leaf of the same plant. This single definite character, constant in the most aberrant forms, seems to me to gather significance as other characters vary, until it becomes as it were a touchstone. Moreover, until dioecious tendencies are made out in *I. saccharata* there is good reason for specific distinction.

Media, Pa.

On some species of the genus Meliola.

F. S. EARLE.

Meliola tenuis B. & C.

A fungus was distributed under the above name by Ravenel[1] on leaves of Arundinaria from Darien, Ga., but no description was given. It is mentioned by Cooke,[2] who merely remarks: "Scarcely different from *Meliola amphitricha.*" It is mentioned by Saccardo[3] under the heading "*Species mihi minus notæ*", where he simply quotes Cooke's remark as given above. It is next mentioned by Martin[4] as Ravenel's no. 330. He gives no description, but says: "This appears to be *M. amphitricha* Fr.

In the *Supplementum Universale* Saccardo[5] publishes a description for the first time. It is as follows: "*Meliola tenuis* B. & C., Ravenel, Fungi Amer. Exsic. *no. 831* (without description).—Epiphyllous, forming small, black, hairy, suborbicular spots; perithecia globose, covered with rigid, straight, sharp-pointed setæ; asci 2–4-spored, ellipsoid; sporidia oblong, $50 \times 18–20\mu$, 4-septate, slightly constricted, extremities rounded, fuliginous; pycnidia present, smaller than the perithecia; stylospores oblong, 1-septate, multiguttulate, hyaline, $25–26 \times 6–7\mu$." This description would certainly justify the remarks of Cooke and Martin, that it was near to or identical with *M. amphitricha* Fr.

Gaillard[6] in his admirable monograph places *M. tenuis* B. & C. among "*species dubiæ.*" After quoting Saccardo's description he makes the following remarks: "We have examined authentic specimens from Ravenel's no. 831. They offer the following characters: Spots pulverulent, of a deep black brown color. Mycelium formed of moniliform cells of a pale fuliginous brown, bearing occasionally little spherical swellings, from which globular, thin-walled, sterile conceptacles

[1] Ravenel, Fungi Americani Exsiccati *no. 331.*
[2] Cooke, Ravenel's American Fungi, Grevillea—: 49. D.1878.
[3] Saccardo, Sylloge Fungorum **1**: 70. Je.1882.
[4] Martin, Synopsis of the North American species of Asterina, Dimerosporium and Meliola, Jour. of Mycology **1**: 148. D.1885.
[5] Saccardo, Sylloge Fungorum **9**: 428. S.1891.
[6] Gaillard, Le Genre Meliola; Anatomie, Morphologie, Systematique 117. 1892.

develop. Mycelial setæ very abundant, acicular, thin (200 x6μ), of a clear fuliginous brown, with numerous septa. The moniliform mycelium, the absence of hyphopodia and of spores cause us to place this plant among the doubtful species."

Ravenel's specimens seem to be the only ones known of this fungus. Some confusion exists in quoting his numbers, they being variously given as 330, 331 and 831. These seem to be simply misprints of the same number. The specimen in the herbarium of the Division of Vegetable Physiology and Pathology of the U. S. Department of Agriculture is certainly Fungi Amer. Exsic. *no. 331.*

In the fall of 1893 I was fortunate enough to collect this little-known species on *Arundinaria tecta* at Ocean Springs, Miss. The characters found in these specimens differed so markedly from any described species that I was inclined to think it new, since they afforded the combination of such distinctive marks as the divided tips of the setæ and the conspicuously lobed apical cell of the capitate hyphopodia. I find, however, that it agrees exactly with Ravenel's specimen Fungi Amer. Exsic. no. 331, as represented in the herbarium here.

Saccardo's description is incorrect as to the setæ and he does not mention the hyphopodia at all. The specimens examined by Gaillardwere evidently very imperfect or immature.

The following description is taken from Ravenel's specimen no. 331 in the herbarium of the Division of Vegetable Physiology and Pathology, and from the Mississippi specimens. It is believed to give the true characters of the species:

MELIOLA TENUIS B. & C., nov. desc.—Amphigenous, covering small (2–3^{mm}) black orbicular or at length confluent areas: conidia-bearing mycelium light fuliginous, somewhat flexuous, branched, frequently septate, not constricted at the septa, 6–7μ thick; conidia not observed: perithecia-bearing mycelium abundant, dark fuscous, irregularly flexuous and nodular, frequently septate, 8–9μ thick: capitate hyphopodia abundant, alternate, about 20–25μ long; basal cell short-cylindrical about 8 × 8μ; apical cell broader, usually irregularly but distinctly three or four lobed, 12–15 × 12–20μ; setæ abundant, rigid, dark and opaque, 200–400 × 10μ, acute, the tip often bifid, trifid, or occasionally 4-parted for a distance of 10–20μ: asci ovate, thin-walled, often evanescent, 2–4-spored, 50–70 × 35–40μ: sporidia dark fuscous, 4-septate, constricted at the septa, ends obtusely rounded, 50–60μ long, somewhat flattened, seemingly elliptical, 18–20μ wide in front view, but cylindrical and 12–15μ wide in side view.—On living leaves of Arundinaria, Georgia and Mississippi.

Notes on specimens of Meliola.

Perhaps no group of fungi is in greater confusion in most American herbaria than the species of Meliola and their allies in the other genera of the Perisporiaceæ. This is largely attributable to the fact that the specimens of so many published exsiccati are incorrectly named. Having recently had occasion to examine the specimens in the herbarium of the Division of Vegetable Physiology and Pathology of the U. S. Department of Agriculture, the following notes may prove of general interest:

Meliola amphitricha Fr., Bonin Islands, U. S. North Pacific Exploring Expedition.—This is mentioned by Gaillard[7] among the forms which he refers to *M. amphitricha* Fr., but this specimen differs from his description in the much smaller (only 16 × 12μ) capitate hyphopodia, which often have the apical cell conspicuously lobed, and in the evident false ostiolum of the perithecium. The sporidia also differ in being strictly cylindrical (not elliptical), with the rounded apical cells longer than the rather short medial ones.

Meliola amphitricha Fr., on *Callicarpa americana*, Gainesville, Florida, Ravenel: Fungi Amer. Exsic. *no. 84.*—This is *Meliola cookeana* Speg. It is the same as N. A. F. *no. 1295.*

Meliola amphitricha Fr., on *Gordonia lasianthus*, Louisiana, 1885, coll. Dr. Palmer (herb. no. 1785).—This is *Meliola cryptocarpa* E. & M., and is the same as N. A. F. *no. 1293.*

Meliola amphitricha Fr., on *Laurus carolinensis*, Houston, Texas, 1869, coll. H. W. Ravenel, no. 116*a*.—This is not a Meliola, but is *Asterina dillitescens* E. & M.

Meliola amphitricha Fr., on *Laurus carolinensis*, Ravenel: Fungi Caro. *no. 70.*—This is *Meliola martiniana* Gaillard.[8]

Meliola amphitricha Fr., on *Persea palustris*, Green Cove Springs, Florida, March, 1883, Dr. Martin, N. A. F. *no. 1296.*—This is the type of *Meliola martiniana* Gaillard.[9]

[7] Gaillard, A., Le Genre Meliola 77. 1892.
[8] L. c. 68.
[9] L. c. 68.

Meliola amphitricha Fr., on Persea, Gainesville, Florida, Fungi Amer. Exsic. *no. 82*.—This is not a Meliola. Our specimen has no perithecia, but it is doubtless *Asterina dillitescens* E. & M.

Meliola amphitricha Fr. var. *palmarum* Berk., on *Phoenix dactylifera*, Calcutta, India, Thüm. Mycotheca Universalis *no. 2155*.—This is referred by Gaillard[10] to *Meliola palmicola* Wint. Our specimen while it agrees with the usual form of this species on Sabal in the long, often three-celled hyphopodia, does not show the divided tips of the setæ.

Meliola amphitricha Fr., on Sabal, Gainesville, Florida, Ravenel: Fungi Amer. Exsic. *no. 81*.—This is *Meliola palmicola* Wint.

Meliola camelliæ (Catt.) Sacc., on *Camellia japonica*, Italy, Briosi e Cavara *no. 106*.—This, like the other "sooty molds" following insect injuries, does not at all present the characters of a true Meliola, and I quite agree with Gaillard[11] in excluding them. It is likely that all these true saprophytic forms should be referred to Capnodium, even if the ordinarily accepted definition of that genus has to be extended to include them. They form a natural group and so do the true Meliolas, but they have little in common.

Meliola furcata Lév., Ellis N. A. F. *no. 1297*, (*a*) on *Bignonia capreolata*, Florida, Dr. Martin; (*b*) on Gonolobus, North Carolina, Dr. Thos. F. Wood; (*c*) on *Sabal serrulata*, Florida, Dr. Martin.—Both (*a*) and (*b*) are *Meliola bidentata* Cke. Gonolobus is a new host for this species, but the specimen agrees exactly with the description given by Gaillard[12] and with the specimens on Bignonia; (*c*) is *Meliola Palmicola* Wint.

Meliola furcata Lév., on Bignonia, Gainesville, Florida, Ravenel: Fungi Amer. Exsic. *no. 330*.—This also is *Meliola bidentata* Cke., and is perfectly distinct from *M. furcata* Lév. which is represented in the herbarium by the N. Pacific Exploring Expedition specimen collected by Wright in Nicaragua, but which has not been found in the United States.

Meliola heteromeles (C. & H.), N. A. F. *no. 1546*.—Our specimen seems to be all Capnodium. I find nothing to indicate either Meliola, Meliopsis or Zucalia, where it has been variously placed.

[10] L. c. 101.
[11] L. c. 123.
[12] L. c. 106.

Meliola MacOwaniana Thüm., Mycotheca Universalis *no. 568.* — This is *Dimerosporium Mac Owanianum* (Thüm.) Sacc.[13] The sporidia are only two-celled.

Meliola penzigi Sacc., Briosi e Cavara *no. 135.*—This too is Capnodium, not Meliola.[14]

Meliola psilostomæ Thüm., Mycotheca Universalis *no. 775.* —This is *Dimerosporium psilostomatis* (Thüm.,) Sacc.[15]

Meliola quinquespora Thüm., Mycotheca Universalis *no. 657.*—This is referred by Gaillard[16] to *Meliola inermis* Kal. & Cke.

Meliola sanguinea E. & E., on *Rubus trivialis*, Pointe à la Hache, Louisiana, Jan. 5, 1886, A. B. Langlois.—This is considered by Gaillard[17] to be the same as *Meliola manca* E. & M., which also occurs on Myrica (see N. A. F. *no. 1292.*

Meliola (young), on Ilex, Harris co., Texas, H. W. Ravenel.—This is not Meliola, but *Asterina pelliculosa* Berk. Another specimen on Ilex from Galveston, Texas, collected by Ravenel in 1869, has two leaves like the above showing nothing but *Asterina pelliculosa* Berk., while a third leaf bears a good Meliola, perhaps *M. amphitricha* Fr.

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[13] Saccardo, Sylloge Fungorum 1: 53.
[14] Gaillard, l. c. 123.
[15] Saccardo, Sylloge Fungorum 1: 54.
[16] Gaillard, l. c. 123.
[17] Gaillard, l. c. 37.

Noteworthy anatomical and physiological researches.

The embryo-sac of Taraxacum.

Now that morphological attention among angiosperms, especially the dicotyledons, is being focussed upon the embryo-sac, it is important to note any careful observations that have been made. In *Flora* **82:** 32 *et seq.* 1896, Siegfried Schwere has published an elaborate paper upon *Taraxacum officinale.* Its scope includes the topics: (1) the present condition of the embryological question; (2) the embryo-sac, fertilization and formation of the embryo; (3) formation and resorption of the endosperm; (4) the integuments and later seed coats; (5) the pericarp; (6) biological considerations. Only the main points of the second topic are here considered. The author discovers that Taraxacum often has two ovules in the ovary, which may differ in size, but otherwise show normal development. No fruit was found containing two mature seeds, but two embryo-sacs were seen, each containing an embryo developed sufficiently to show the cotyledons. The egg-cell, which is rather deep in the sac, is easily recognized by its size and contour, and its nucleus is nearly as large as the endosperm nucleus. The synergidæ are at the extreme end of the sac and do not extend into it nearly so far as the egg-cell, and their nuclei are smaller than those of the egg-cell and the endosperm-cell. The synergidæ persist for an unusually long time, retaining a plump appearance after walls have begun to form in the endosperm. The antipodals vary in size, shape and arrangement, but their number, three, is constant. The author seems to doubt Hegelmaier's statement that in Taraxacum he had observed four or five antipodals in a longitudinal row, but recent studies in Compositæ suggest that such a condition is not at all unlikely. The antipodals are said to persist as long as the synergidæ. The author claims to have discovered in Taraxacum the first case of synergid fertilization noted in dicotyledons. Whether such a sac would develop two embryos or not is a question yet to be determined.

The first division of the fertilized egg-cell separates an embryo-cell from a suspensor-cell, and the latter retains its character during the first divisions of the embryo, after which it begins to divide in basipetal order. When the embryo begins to show cotyledons, the suspensor, with the exception of the so-called "hypophysis," contains a row of from two to four cells. When the growing cotyledons have given the embryo the characteristic cordate form, the number of suspensor-cells is also found to have been increased. The "Anschlusszelle," or suspensor cell next the embryo, plays a special rôle. The other suspensor cells divide in somewhat irregular fashion, but in this one the first wall is vertical, and vertical divisions follow in planes at right angles to each other. This does not agree with Fleischer's account of Helianthus, in which the Anschlusszelle has two transverse walls before vertical divisions begin. A little later, vertical divisions occur in the cell below the Anschlusszelle. The descendants of these two cells take part in the formation of the embryo, which by this addition has become nearly spherical.—CHAS. CHAMBERLAIN.

Correlation effects following mechanical hindrance of growth.

In a recent contribution on growth-correlations, Dr. Franz Hering[1] reports some very interesting results. He takes issue with the conclusion reached by Kny[2] that the growth of root and shoot of seedlings proceeds with a high degree of independence, and points out that in his study Kny took cognizance only of the end-results of growth through long periods and neglected to look for temporary modifications that were soon concealed by further growth. Hering finds that interdependence between these systems is pronounced. He cites experiments by Stone showing that when the epicotyl was removed from a seedling, the growth rate of the root immediately decreased; after a time, however, it regained and, indeed, surpassed its normal rate, as a result of the increased activity connected with the process of repair. In consequence, the total growth during an extended period would equal or exceed that of the control objects.

By use of Pfeffer's method of confining parts in plaster of Paris casts, the author investigated the action resulting from mechanical hindrance of the growth of a system, or of a part

[1] Ueber Wachsthumscorrelationen in Folge mechanischer Hemmung des Wachsens. Pringsh. Jahrb. f. wiss. Botanik **29**: 132–170. 1896.

[2] Annals of Botany **8**: 265. 1894.

of a system on adjacent and on remote parts of the plant. When either the root or the shoot system was incased, a plain retardation of the growth of the free system was always seen. This retardation differed somewhat from that observed when the part was simply amputated. Instead of a recovery following the shock from the injury, the author found that the continued irritation from the confined parts caused a likewise continued retardation with a total growth (in the case of the radicle) averaging about two-thirds of that of the control. Upon freeing the confined parts, a plainly marked acceleration of the growth rate of both systems followed.

The cotyledons of Streptocarpus behaved in a very interesting manner. Normally one cotyledon grows until it reaches considerable dimensions. The other, however, remains rudimentary, and finally dies. When the cotyledon in the usual order of things predestined to development was put in the cast, the smaller usually fugacious member assumed the rôle and grew, provided the development of the seedling had not already proceeded too far. A similar result was obtained by the extirpation of the larger cotyledon. Thus the prevention of growth in one part can awaken it in another.

The question of correlation within a particular system was investigated. If the cast was so placed as to leave free the apex and entire growing zone of a radicle, a retarded growth resulted. Neither the revival of growth in old tissues, nor a changed distribution of growth was found to follow the application of the cast preventing normal elongation. When only partially hindered, growth was reduced but not re-localized.

When shoots of various kinds of seedlings were correspondingly treated, the correlation phenomena agreed completely with those seen in roots. Shoots so enclosed that growth in length merely was prevented, grew abnormally in thickness, but on the release from the cast it was resumed in the parts still plastic.

From these results, it appears that, without sufficient development in the sustaining parts, the sustained meristematic regions are unable to make a strong development.—R. H. TRUE.

Fertilization of Batrachospermum.

In the *Annals of Botany* (March) Dr. Bradley M. Davis has recorded some important results from his study of the fertilization of Batrachospermum. The species chiefly studied was *B. moniliforme*, subsequently checked by a study of two other species, *B. coerulescens* and *B. Boryanum.* The results have to do not merely with the genus studied but with the whole subject of fertilization. The trichogyne of Batrachospermum is found to be a cell entirely distinct from the so-called carpogonium, as witnessed by its well-organized nucleus and its chromatophore. The antherozoids also contain a chromatophore derived from the vegetative cells, and a distinct nucleus. In the act of fertilization the antherozoid and trichogyne walls fuse, a larger or smaller opening is developed, and cytoplasmic fusion occurs, but the antherozoid and trichogyne nuclei remain distinct, apparently indifferent to the process, the antherozoid nucleus for the most part not even entering the trichogyne. As soon as cytoplasmic fusion occurs the trichogyne becomes separated from the carpogonium by the gradual drawing apart of the cell-contents until the connecting strand becomes so thin that it breaks, and by a deposit of substance similar to cell-wall material. The carpogonium subsequently gives rise to the spore-producing filaments. The nuclei of the antherozoid and of the trichogyne were repeatedly observed in various stages of fragmentation after fertilization had been accomplished. The striking results are the distinct cell-nature of the trichogyne, and the process of fertilization, consisting as it does of fusion which does not involve the nuclei. That all fertilization hitherto observed involves cytoplasmic fusion as well as nuclear is well-known; but that it should be so modified as to involve the former and not the latter is entirely unexpected. It is not necessary to conclude that nuclear fusion may not be an essential feature of well-organized fertilization, for these observations upon Batrachospermum may indicate, as Dr. Davis suggests, that the genus is losing its sexual habit, and is tending toward apogamy. Even if this be true, however, the puzzling feature still remains that the carpogonium will not produce its fertile filaments, as clearly shown by experiments, without the antherozoid contact. It is evident, therefore, that the fusion, even if the nuclei are not concerned, shows its sexual character in its effect. The author also suggests the hypothesis that sexual reproduction in these low forms may not of necessity involve nuclear fusion. We certainly know too little concerning the behavior of the nuclei in the sexual processes of the thallophytes in general, and concerning the whole trichogyne subject in particular, to venture upon much generalization concerning these very interesting and important observations upon Batrachospermum.

BRIEFER ARTICLES.

Some new or rare plants.—Phaseolus (Drepanospron) **smilacifolius,** n. sp.—Stem scandent, strigose-pubescent, 5–12^{ft} high, twining over bushes with the habit of Apios: leaflets large, 5–6^{cm} long, 5^{cm} broad, thin, glabrous above and below, in outline deltoid-hastate, usually more or less 3-lobed, the basal lobes rounded, the apical one acute; stipules and stipels linear, minute, persistent: flowers in loose elongated racemes; pedicels filiform, unibracteate at base, 1–1.5^{cm} long: calyx campanulate, with five obscure very obtuse teeth: corolla pink or white, rather large, 1^{cm} long: legume nearly straight, glabrate, much compressed, 4–6-seeded, 5–6^{cm} long, 1^{cm} broad.

The section Drepanospron of Bentham, or Euphaseolus, to which this species belongs, is distinguished from the Strophostyles group chiefly by the racemose or often paniculate, instead of capitate inflorescence. The other North American members of the section are *P. retusus* Benth. and *P. Wrightii* Gray, both from the southwest: *P. sinuatus* Nutt., a Florida species, and our common northern wild bean, *P. polystachyus* (L.) B. S. P. Of these *P. Wrightii* has leaflets very deeply and very variously lobed, while the other species have rhombic-ovate nearly entire leaflets; our plant is remarkable both for the similarity of its leaves to those of *Smilax Bona-Nox*, and for their thin texture; the legume, moreover, is very nearly straight, and not falcate as in other members of the group. It was found in abundance by Mr. George V. Nash on hammock land near Lake City, Florida, August 31, 1895 (type no. 2505 in U. S. National Herbarium.)

Phacelia Covillei S. Watson in Gray Man. 360. 1891. [Ed. 6.]—This interesting little Phacelia was collected originally May 5, 1889, by Mr. Frederick V. Coville on Larkspur island in the Potomac, about five miles above Washington, D. C. The plants were sent to Dr. Watson for determination, and were finally identified and described by him as a new species.

Larkspur island is the third in the series of islands above Little Falls. It is lower than most of the others, and was apparently inundated by the floods resulting from the heavy rains of the ensuing season. At all events, no trace of the plant could be discovered, either in the original locality or on any adjacent island until last April, when it was found most unexpectedly by Mr. Coville, Mr. Hicks, and others, including the writer, at several points along the river bank above Glen Echo, Maryland, very nearly opposite its original station.

In every case it grew in moist alluvial soil and was unaccompanied by either *Ellisia nyctelea* or *Phacelia parviflora*, between which *P. Covillei* has been supposed by some to be a hybrid. It is apparently the only eastern Phacelia with a campanulate corolla; and this circumstance, together with the fact that it has the aspect of Ellisia and the capsule of Phacelia, no doubt suggested the theory of possible hybridization.

PERILLA FRUTESCENS (L.) Britton, Mem. Torr. Club **5**: 277. 1894.

Ocimum frutescens L., Sp. Pl. 597. 1753.

Perilla ocimoides L., Gen. Pl. Ed. 6, Add. 578. 1764.

This Asiatic mint is reported in the last edition of Gray's Manual[1] on the authority of Schneck, as growing about dwellings and roadsides in southern Illinois. It had been collected by Professor Lester F. Ward at Crystal Spring in the District of Columbia, and is included in the "Catalogue of the Plants of the District"[2] though referred with hesitation to Bentham's variety *crispa*[3] which is a mere garden form. Additional specimens have been examined in the Herbarium of Columbia College collected at scattered points in New York, New Jersey, Pennsylvania, West Virginia, Georgia and Missouri. On October 28, 1895, Mr. L. H. Dewey and the writer came most unexpectedly on the plant growing in a large patch on the border of some woods near Waterloo Station, Alexandria Co., Va. It was then in good fruiting condition and easily identifiable.

CASSIA MULTIPINNATA NASHII Pollard, Bull. Torr. Club. **22**: 515. 1895. —Since the publication of some notes on Florida cassias, specimens have been received from Miss Josephine Skehan, collected the past summer at Ocean Springs, Mississippi, which are undoubtedly referable to the above variety, having all the characters of *C. multipinnata*, but being of low, diffuse habit. The plant may very probably occur at different points along the Gulf coast, both in the typical and the varietal form[4].

LIMNANTHEMUM NYMPHOIDES Hoffmg. & Link, Fl. Port. 1: 344. 1809.—This plant, together with *Trapa natans*, has become so thoroughly naturalized in ponds of the U. S. Fish Commission in Washington that it covers the surface of the water and has spread into several adjacent pools. In October a beautiful sight is presented by the multitude of yellow blossoms open in the sunlight.

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[1]Gray. Man. 407. 1891. [Ed 6.]

[2]Bull. U. S. Nat. Mus. **22**: 104. 1881.

[3]DC. Prodr. **12**: 164. 1848

[4]Since the above was written, Prof. S. M. Tracy, of the Mississippi Agricultural Experiment Station, has sent me a complete representation of the cassias growing in that state, from which it appears that both *C. multipinnata* in the typical form and *C. depressa* (loc. cit.) occur there.

Rhamnus Frangula L., Sp. Pl. 193. 1753.—Mr. W. M. Van Sickle, of West New York, N. J., reports the discovery of additional specimens of this interesting European buckthorn in the swamp at Secaucus, some distance from the present known locality at New Durham. The problem concerning its mode of introduction into the United States is a difficult one to solve. The fact of Michaux's Arboretum having been situated on the site of the present New Durham swamp indicates that it may have been originally planted there, an d thriving under favorable conditions, spread rapidly and in time developed trees of the size now found. It was long ago rep orted from Flushing, Long Island, but this station is now apparently obliterated.—Charles Louis Pollard, *Washington, D. C.*

Pebble mimicry in Philippine island beans.—In looking over a keg of pebbles collected from the coast of Marinduque by Dr. Joseph B. Steere in his expedition of 1887–8, some beans were found which surprisingly resemble the water-worn pebbles with which they were associated. The mimicry is so perfect that almost every one is deceived until an opportunity for handling them is afforded, and even after being made aware of their nature mistakes will still occur. Inquiry developed the fact that these beans are produced by a coarse briar confined, as was expected, to the narrow strip of gravelly beach and met with here and there upon various members of this group of islands. Sending out trailing stems to a distance of twenty to thirty feet, carrying a leaf similar to that of the rose, they form a mat from three to four feet in height quite difficult to penetrate. Dr. Steere found the natives collecting them for shipment to Manila, to be used, as they said, in the manufacture of soap.

The beans, themselves, are sub-ellipsoidal in form, but show much irregularity in shape, apparently from mutual pressure in the pod. Indeed, here is one of the striking points of the mimicry, some perfectly resembling well rounded beach pebbles, while others mimic pebbles which have been broken across and then had their sharp edges rounded by continued friction. A handful of the beans shows as much and the same character of variation as is seen in the same number of quartz pebbles. The size is as variable as the shape, the three dimensions ranging in different specimens studied from 10 to 23^{mm}; in a typical specimen being about $17 \times 18 \times 14^{mm}$. The color varies from moderately dark to light drab, some giving a faint greenish tinge, while the luster of many is exactly that of chert pebbles. In others of lighter color the effect is similar to that obtained from pebbles of chalcedony or of crystallized quartz. Nearly all the specimens show a series of approximately parallel darker lines passing around, very suggestive of stratification. All are quite hard, cut only with difficulty with a knife, and when shaken together in the hand give that clinking sound, only somewhat duller, which is characteristic of pebbles. The mimicry then is that of mixed quartz pebbles and covers *shape*, *size*, *color*, *luster*, *hardness* and *stratification*. It is so complete and perfect that it can not be regarded as mere coincidence. Placed in water the beans are found to be buoyant and nine weeks soaking in sea water, at about 70° F. seems to make no impression upon them, proving that they might be transported to considerable distance by waves and ocean currents.

It becomes a matter of interest to offer some speculation as to how this mimicry may have been produced since the principles involved seem to be just the opposite of those which usually hold for seeds. In the first place we must assume that we have had a plant growing within or near tide limits and supplying food for mammals or birds, distributed over the adjacent islands. It is true that these seeds are now very hard and exceedingly bitter, but these qualities may have developed along with the others for which we are to account. Indeed, they have been asking favors of neither fowl nor beast but pleading in their own way to be simply let alone. From any particular crop of seeds those most conspicuous would be carried away first, and if any remained they would probably be those, which from their external characters, most resembled the pebbles about them. It would be these from which would be produced the new plants as the parents died out, or from which, when floated to adjacent shores, new colonies would be founded. It is believed, eminent authority to the contrary, that these would have a *tendency* to produce seeds somewhat similar. Very many of the conspicuous variety would continue to appear through a long series of generations, but it would be these always which would be first to be gathered and carried away. This selection continued through an indefinite time, combined with the tendency to transmit the parental characters to the offspring, would bring about the described results. In general, those seeds which fail to secure distribution are smothered out by the parent plant or by the favored one which gets the start of its fellows. Individual characters are soon obliterated through cross-fertilization. In the case of these beans, however, the waves and currents step in and quietly bear them to other shores where large numbers, which have been subjected to this selecting process, may have an opportunity for simultaneous growth and development. In the case of the Philippines there may thus take place with relative rapidity what might otherwise be impossible on a continuous stretch of coast alone. Somewhere upon the islands, either upon the coast or inland, we should expect to find one or more related species, bearing conspicuous, softer and more palatable seeds (as in the case of the so-called "Florida bean"), the ancestors of which had been carried from the beach when the process of selection in the two directions began.—W. H. SHERZER, *State Normal School, Ypsilanti, Mich.*

Lichens, the only "thallophytes."—It is with great pleasure that I go through the new text-books of botany; their wealth of material and new views of classification are of extreme interest. The large amount of space devoted to cryptogams, more especially to the lower cryptogams, is in great contrast to the limited space accorded them in earlier works. The general method, too, is quite different; there is everywhere a severe strain after the homologies, while the analogies and affinities of the old botanists are scarcely considered.

We are furnished with new terms in vast profusion, contributing greatly to conciseness of thought and facility of expression. It would seem superfluous to ask for anything more in this respect; nevertheless it seems to me it would conduce greatly to ease and brevity of reference and description, to have a technical term for the vegetative system, and another for the reproductive system of plants in general. It is true that *vegetation* and *fructification* are made use of, but they are not technical terms, because they are employed with other meanings.

Fitting terms are used in some of the classes of plants. The vegetative and reproductive systems of a fungus are clearly and broadly indicated by *mycelium* and *sporophore*, those of a myxomycete by *plasmodium* and *sporangium*, of a lichen by *thallus* and *apothecium*. But in descriptive works upon the algæ, there is great confusion and uncertainty in the terms; we find cell, thread, filament, frond, stem, etc., in common use for the vegetative system and a greater multitude of terms for the reproductive system. These are all well enough in their special applications, but there is need of a pair of contrasting terms for each separate function in general. Wallroth, who was much given to invention of terms, employed the term *physeuma* to cover "frons, filum, caulis, folium" of Agardh.

This leads me to speak of the term *thallus*. The usage of the writers of the text-books and that of the writers of systematic works do not coincide. None of the latter speak of the *thallus* of a fungus; they say *mycelium*, or sometimes they revert to the component *hyphæ*. Even in certain cases where its use might be suggested, as in *Solenia anomala* Pers., we find the tubules "sitting on a *mycelium*," or in "*Peziza fusca* Pers., where the ascomata rest on a "*subiculum*." I have not observed the *thallus* of the Myxomycetes to be written even in the text-books.

The use of the term *thallus* is now practically confined to the Lichens and more especially to the thin flat expansions, either foliaceous or crustaceous of the vegetative system. Its use in this same sense is transferred to certain plants not only among the Algæ but also in the Hepaticæ. Here, however, the better term would be *thallode*. Hence, so far as the usage of systematic works is concerned, the denomination Thallophyta of the text-books applies only to the lichens.

Finally, it is with some amazement that I view the new systems of classification in the most recent text-books. In the lower cryptogams there is an evident recoil to the Algæ and the Fungi, if not of Linnaeus, of Agardh and Fries. This is a return to a consideration of the vegetative system of these plants instead of the reproductive. On this account it would seem necessarily to involve the setting apart again of the lichens, whose vegetative system is now known to be unique among plants. Up to date, then, the gain in general classification has been only to segregate the Myxomycetes as an independent class. But in the development of the subordinate members of the scheme, the progress has been wonderful, though it is not yet by any means complete.—A. P. MORGAN, *Preston, O.*

Bibliography of American Botany.—The author catalogue on cards issued under the direction of the Bibliography Committee has completed its second year and is steadily growing. The first and smallest issue numbered seventeen cards; the largest (Nov. 1895) numbered 89 cards. The average monthly issue for 1894 was 49 cards, for 1895, 63 cards. The total issue for 1894 and 1895 is 1,343 cards.

In response to various requests an edition by subjects is in preparation, but as yet no fully satisfactory subject-classification has been found. Botanists would confer a great favor, and advance the work, by sending the committee any suggestions to this end, and particularly by stating what subjects and what phases of botanical science they would like to have the catalogues show, each for his special purpose. The committee is working in the interests of American botanists and wish to adapt the work to their needs. Address the Secretary of the Committee on Bibliography, 1286 Massachusetts Ave., Cambridge, Mass.

CURRENT LITERATURE.

Plant anatomy.

Most teachers of botany have felt the need of a brief and comprehensive account of the tissues of plants. Such a book—"a brief outline of the elementary principles of anatomy"—it has been the aim of of Dr. Emily L. Gregory of Barnard College to prepare.[1] The book is of very convenient size and appeals to one on this ground as probably just what he is in need of. A glance at the table of contents strengthens the favorable impression. The subject is logically and comprehensively mapped out. It is divided into two parts, the anatomy of the cell and anatomy of tissues, the latter including not only tissues and systems but also an outline of the anatomy of the vegetative body of the thallophytes and "cormophytes." When the body of the book is reached, the favorable impression is somewhat modified. Amid much that is good, well-put, and correct, there is much that is crude, incorrect, or out of date.

The explanation of the molecular structure of "organic substance" —by which we suppose organized bodies are meant—is defective, but the first striking weakness is encountered in the discussion of the cell nucleus. Here, in the absence of any recognition of the nucleus as determining the cell and therefore the ascription of a plurality of nuclei to one cell, in the statement that "the chemical nature of the nucleus is the same as that of the cytoplasm," in the incompleteness of the account of mitosis, and in the absence of any reference whatever to the centrospheres, we see indications that these parts of the lectures were prepared some time ago and have not been brought up to date. It is in this section too that we meet again that unseemly phrase, which grates so often upon the teacher's ear from the mouths of students, "some scientists claim!" With variations, "it is also claimed," "it is claimed by some authorities," "it is believed by most authorities," etc., this crude expression recurs again and again, until we are forced to believe that the author had relinquished all hope that her book would be considered "an authority."

Other points also need to be revised in the light of more recent knowledge, such as the structure and chemistry of the starch grain, the function of leucoplasts, the epidermal system, the sieve tissue, and the types of stem structure.

[1] Gregory, Emily L.—Elements of plant anatomy. 8vo. pp. viii+148. figs. 64. Boston: Ginn & Co. 1895.

Of some statements we can find no explanation except that the author has mistaken the facts, but we cannot undertake to give illustrations of these. There is certainly confusion regarding the secondary bast fibers, that is those produced by the secondary meristem of the bundle, and the similar tissues arising from the pericycle. We cannot understand in what sense "tracheids are to the ducts what the accompanying [i. e., companion] cells are to the sieve-tubes of the phloem, namely assisting cells." If mono- and dicotyledonous types of stem structure are distinguished, is it not a serious objection to such a distinction to have to say regarding monocotyledons which undergo secondary thickening that "the stems which do admit of such increase may be considered as having changed from the mono- to the dicotyledonous type?" And this is unintelligible: "In general it [the cambium ring] may be said to be formed either by the intercalation of new bundles, or by the formation of interfascicular cambium." Is this "what is commonly called bark, namely all that portion of the stem outside the inner periderm?"

So we turn from the book with regret, wishing it were better, and hoping that by a careful revision Dr. Gregory will be able to furnish us a much needed text-book. It ought to be suggested to the publishers, also, that they seek to emulate the delicacy and softness of the illustrations in Strasburger's works, and avoid the coarse harsh style in which they have produced these.

Botany for pharmacists.

The book before us[1] is really a double one whose back title, side title, title pages and sub-titles are rather puzzling. The confusion, doubtless due to an inexperienced publisher, resolves itself thus: Drs. Rusby and Jeliffe have written for a pharmaceutical journal a series of articles, which are reprinted apparently from the original setting (as the pages are double columned), treating of the anatomy of plants from the point of view of the pharmacist. Dr. Rusby writes of gross structure and Dr. Jeliffe of histology.

Dr. Rusby, after a good introduction of five pages, devotes nearly two-thirds of his 100 pages to the flower, fruit, and seed, leaving only thirty-five for the other plant parts. The greater part of this section is a running glossary with only a cursory account of the morphology and physiology of the organs. In the "anthology" a confusing at-

[1]Essentials of vegetable pharmacognosy; a treatise on structural botany designed especially for pharmaceutical and medical students, pharmacists and physicians. Part I. The gross structure of plants, by Henry H. Rusby. Part II. The minute structure of plants by Smith Ely Jeliffe. 8vo. pp. vi + 150. figs. 560. New York: D. O. Haynes & Co. 1895.

tempt is made to present the modern view of the pollen-grains and ovules, as these sentences will show:

"These correspond, though of the other sex, to the macrospores which we have found the pistillate flowers to produce, and they are called microspores, in flowering plants called pollen-grains."

"If as in the alder, pistillate flowers and staminate flowers, or, otherwise stated, spores of both sexes, are produced by the same plant, it is monœcious.

The following account of the morphology of the anther, as well as the succeeding quotation regarding the pollen-grain, seem to indicate that the author has scarcely understood the homologies involved.

"Its origin from the leaf assumes the curving forward and inward of the margins of the blade to become attached to the face of the mid-rib, producing two thecæ, and the production of a secondary or "false" partition separating each theca longitudinally into two locelli."

"The pollen-grain consists of a highly hygroscopic mass of tissue, partly vital and partly nutritive."

The excellent illustrations, new, accurate, and clear, deserve high praise. Had they been numbered in type and an explanation or at least the names of each been given, it would have been a decided improvement.

Dr. Jeliffe's "outline of practical plant anatomy," as one title page calls it, is a greatly condensed account of the tissues, classified essentially as by Tschirch in his *Angewandte Pflanzenanatomie*, and illustrated by many cuts from that work. It is difficult to see how one who can write thus about the cell wall and the vacuoles can be fitted to prepare even an outline of plant histology:

"The lining membrane is called the cell wall. It is not always present, as in many one-celled plants, as yeast, nor is to be found in the youngest growing parts of the plant, as in the apices of stems and roots, nor in the immature pollen-grains."

"After the cells commence to grow portions of the cytoplasm are consumed in the building up of the plant, and small vacuoles appear in it."

"Vacuoles and other spaces left by the retreating protoplasm."

And this difficulty is increased when we find him defining "respiratory tissues" as "those which enable the plant to take in food from the atmosphere in the form of carbon dioxide and to give off oxygen and watery vapor."

While the authors' work is faulty in many particulars it is not easy to find any in which the publisher's is what it ought to be, if we except paper. The clumsy binding, the old brevier type in double columns loaded with capitals, the cuts numbered in two series while the pages are numbered consecutively, and the want of an index conspire to repel further acquaintance.

North American Cactaceæ.

Our North American species of *Cactaceæ* are now brought together[1] as a result of the studies of Dr. John M. Coulter.

The first part (no. 2, published in June, 1894) contained the genus *Cactus* (Mamillaria) and its small outliers, *Anhalonium* and *Lophophora;* the second part (no. 7, published in April, 1896) completes the work by presenting *Echinocactus*, *Cereus*, and *Opuntia*. The revision is called "preliminary" because confused and inadequate material, a badly tangled synonymy, and paucity of types could result in nothing else. It is also preliminary in the sense that it professes to do little more than to bring together the widely scattered material, sift it so far as possible, and thus lay the foundation for more elaborate study. It is probable that no group among the higher plants presents greater difficulties in the way of classification, both on account of the meager and fragmentary material, and also on account of the almost entirely unknown possibilities of variation. Having been very largely cultivated in Europe as well as America many modified forms have been produced, many garden species and varieties have been described, and these have vastly complicated the work of revision. It is certain that very many forms described, both in the revision before us and elsewhere, will be found undeserving of specific and varietal rank, but this can be discovered with certainty only by long continued and patient scientific cultivation. In few families are there such poorly defined generic lines, even our well-known North American genera exhibiting most puzzling intergrading forms. It may be safely said that in Cactaceæ there are few good species, as that term goes, and no genera. The monographer had a rare opportunity in his access to Dr. Engelmann's types and notes, many of the latter being first published in the present revision. If the North American species north of the Mexican boundary were the only ones concerned, some reasonable degree of certainty might be reached, but the well-nigh unknown cactus-flora of Mexico constitutes a necessary and unexplored background. Taking up the three genera of the *Contribution* just issued, we find *Echinocactus* containing fifty-two species and varieties, thirty-six of which are found within the United States; *Cereus* eighty-two species and varieties, of which twenty-nine are north of the Mexican boundary; and *Opuntia* 101 species and varieties, seventy-nine of which are found within our borders. It should be said, however, that this well represents only the forms found within the United States, as only such Mexican forms are included as could be examined. Numerous

[1] Contributions from the U. S. National Herbarium **3:** 91–132, 355–462.

new species indicated in Dr. Engelmann's manuscript notes and of the monographer are described, more by way of recording forms than with any expectation that they will stand the test of future investigation. Artificial keys supplement the presentation of each genus which will serve a useful purpose in recognizing material which is generally incomplete. It is hoped that this bringing together of our material in convenient shape will provoke investigation, especially since competent observers are multiplying in the cactus regions; and that the next revision will show large progress in our knowledge of this extremely interesting and perplexing group.

The bacteria.

In Engler & Prantl's *Die natürlichen Pflanzenfamilien*, the Schizomycetes or bacteria are united with the Schizophyceæ or fission-algæ into the Schizophyta. The first class has recently been issued as Lieferung 129, and is from the pen of Prof. W. Migula, the well-known bacteriologist.

The difficulties to be surmounted in a systematic treatment of the bacteria are well recognized. Their simplicity of structure and variability of function together with imperfect descriptions, the majority of which have been recorded by non-botanical bacteriologists and the almost interminably confused synonymy make an exhaustive treatment of this group practically impossible from a taxonomic standpoint. Numerous systems of classification have been proposed from time to time, but many of these have been tentative, being based on convenience more than on natural affinities. Some have been constructed purely from the morphological standpoint, while others have assigned to functional characters a value equal to that of form.

Migula has prefaced his system with an exceedingly well written and concise account of the morphology and physiology of the bacteria. Reference is also made to geographical distribution, the relationship of the bacteria to closely allied groups, and some very pertinent observations on the subject of bacterial nomenclature. He deprecates the introduction of generic terms that are based on some biological property such as *Halibacterium* Fischer, *Photobacterium* Beyerinck, *Nitrosomonas* and *Nitromonas* of Winogradsky, inasmuch as these groups are well defined morphologically and can be satisfactorily arranged under the usual laws that govern systematic classification.

He further objects to the attempt to translate into Latin the species diagnosis and use it for a species name, as it is not only unwieldy in practice but is opposed to the present accepted taxonomic principles For instance, *Bacillus fluorescens liquefaciens minutissimus* Unna and similar titles are at variance with the accepted principles of the binomial nomenclature.

Migula's classification is based primarily on morphological and developmental differentiation, and in the selection of these characters he uses those that are the most permanent, subordinating the more transient, such as the presence and distribution of cilia, to lesser divisions.

The following synopsis gives the salient features of his system:

I. Cells when isolated spherical, not elongating before cell division. Cell division in 1, 2 or 3 planes. . . . . 1. *Coccaceæ.*

II. Cells cylindrical (short or long) dividing in only one plane, and elongating before division.

a. Cells straight, rod-like, devoid of sheath, immotile or motile by means of cilia, ... 2. *Bacteriaceæ.*

b. Cells curved, without sheath, ... 3. *Spirillaceæ.*

c. Cells surrounded with a sheath, . . . 4. *Chlamydobacteriaceæ.*

d. Cells without sheath, united into filaments, motile by undulating membranes, ... 5. *Beggiatoaceæ.*

The division of genera in the different families is likewise accomplished by the use of morphological characters such as the presence or absence of locomotor organs, protoplasmic inclusions like sulfur grains and, in the more specialized groups, the arrangement of cell filaments. Biological characters such pathogenicity, chromogenesis and zymogenesis are only used to differentiate related groups in various genera.

No attempt is made to classify all of the species already recorded, but a brief description is appended of a few representative forms under each group. The system will doubtless be regarded as the most successful attempt that has yet been made to outline the classification of this group on morphological lines.

It certainly represents an advance over any of its predecessors, and is superior to the contemporaneous systems that have been suggested within the last few years. The prestige of the publication of which it forms a part will doubtless strengthen its authority and lead to its adoption by botanical bacteriologists.—H. L. Russell.

Minor Notices.

The authors have recently issued decades XVII and XVIII of "*Hepaticæ Americanæ*, prepared by L. M. Underwood and O. F. Cook." It has been three years since the last decades were issued, and we are pleased to find that there has been no abatement of the original plan to issue exsiccatæ of all the North American species. There are nine contributors, beside the authors, to the present score of numbers: C. V. Piper, D. H. Campbell, F. C. Straub, M. A. Howe, A. W. Evans, E. L. Rand, W. C. Werner, J. Macoun and A. B. Langlois. The species and place of collection are as follows: *Anthoceros laevis* L. and *A. Hallii* Aust. from Washington; *A. fusiformis* Aust., California; *A. Carolinianus* Michx., Florida; *Riccia nigrella* DC., California; *Aytonia erythrosperma* (Sull.) Underw., Washington; *Cyathophora quadrata* (Scop.) Trevis., New York; *Lepidozia sphagnicola* Evans, Connecticut; *Nardia Macounii* Underw. *n. sp.*, Washington; *Chiloscyphus polyanthos rivularis* Nees, California; *Plagiochila Virginica* Evans, District of Columbia; *Jungermania Novæ-Cæsareæ* Evans, New Jersey; *Cephalozia fluitans* (Nees) Spruce, Maine; *C. Turneri* (Hook.) Lindb., California; *Porella pinnata* L., Indiana; *Frullania Selwyniana* Pears., Ohio; *Lejeunea Macounii* Spruce, British Columbia; *L. serpyllifolia* (Dicks.) Lib., Florida; *Kantia Sprengelii* (Mart.), Louisiana; and *Blepharostoma nematodes* (Aust.), Florida.

OPEN LETTERS.

"Nature of the binary name," again.

Professor Greene does me an unmerited honor in discussing so fully my humble suggestion respecting the nature of the binary name. I asked if the name of a plant is one word or two. Professor Greene's reply is most ingenious and one which, I must admit, had never occurred to me. His chief reply is in the form of a suppositious case. He supposes that I could lecture for an hour or more on Carex, and mention any number of species, and yet not even once use the word Carex; therefore, the specific name is, in that case, *the name* of the plant. Very well; I might so lecture (to empty seats, of course); but my hearer (if, perchance, I should have one) would know that the word *Carex* is understood in every case. The group and the name of that group would be constantly in his mind. But if one were lecturing upon distribution of plants, morphology, or a dozen other botanical subjects, he would be obliged to use the generic name whenever he used a specific name, and both words—the combination—would appeal to every hearer as *the name*. It is a mere incident, it seems to me, whether the generic name is expressed or understood: in either case, both words are assumed as coordinate parts of the conception of a plant name.

I am sorry to be so obtuse and insistent. But I hope that Professor Greene will kindly help me still further out of my difficulty. The question which was propounded seems to me to be central to the whole nomenclatorial controversy. It seemed so five years ago, when I first ventured the proposition; but the fact that no one took up the issue seemed to show that my trouble was simply a personal perplexity and devoid of merit in itself.—L. H. Bailey, *Cornell University, Ithaca, N. Y.*

NOTES AND NEWS.

Dr. C. A. J. A. Oudemans has resigned the professorship of botany in the University of Amsterdam, on account of his advanced age.

The *Icones Plantarum* is hereafter to be edited by the Director of Kew Gardens, a duty performed since 1891 by Professor Daniel Oliver.

Dr. J. Mueller, Director of the Botanic Garden and Curator of the Delessert Herbarium at Geneva, died January 28th in his 68th year.

Mr. L. S. Cheney, instructor in botany in the University of Wisconsin, has been promoted to be assistant professor of botany in the college of pharmacy.

There were more than 1,400,000 visitors at the Kew Gardens during 1895. The month of largest attendance was June, with nearly 300,000, and the smallest February, with little over 12,000.

The new Mexican *Lippia iodantha* Rob. & Greenm. is figured in *Garden and Forest* for March 11th, with a brief informal description in "Notes of Mexican Travel" by C. G. Pringle.

A popular article on ferns by Willard N. Clute, profusely illustrated, and unusually well written, appears in the *Commercial Travelers' Home Magazine* for March (**6**: 271–278.)

Prof. D. T. MacDougal, of the University of Minnesota, expects to spend the summer in Tübingen, in the laboratory of Prof. Vöchting, where he may be addressed during June, July and August.

E. Knoblauch (*Ber. Deutsch. Bot. Gesell.* **13**: 289) announces the discovery of heterostylous flowers in several genera of *Gentianaceæ* notably *Hockinia*. This dimorphism is plainly correlated with the visits of insects.

Another parasite producing scab on potato tuber has been found in Hungary by K. Schilberscky (Ber. d. d. bot. Ges. **14**: 36–37). It belongs to the Chytridineæ, and is named by the discoverer, Chrysophlyctis endobiotica.

Interesting accounts of the difficulties and pleasures met with in searching for the rare fern, *Schizæa pusilla*, are given in the April number of the *Linnæan Fern Bulletin*, by Mrs. Elizabeth G. Britton and Mr. C. F. Saunders.

Dr. Rodney H. True has been promoted from instructor to assistant professor of pharmacognosy in the University of Wisconsin. Dr. True's thorough training in botany will enable him to give his students a genuine scientific background for their practical work.

Mr. O. F. Cook, who made his third trip to Africa last October, is expected to land in New York about the middle of April. He spent less than three months in Liberia this trip, but reports a successful journey and large collections as usual. He returns via Hamburg and will spend some time in the Berlin museum before his return.

MESSRS. D. T. MacDougal of the University of Minnesota, Geo. J. Peirce of the State University of Indiana and R. A. Harper of Lake Forest University have recently been elected to membership in the Deutsche Botanische Gesellschaft.

WEED LEGISLATION in the United States has been summarized by L. H. Dewey in a very complete manner (Bull. U. S. Dept. Agric., Div. Bot., no. 17, 1896, pp. 60). The work must prove of much service to those who are interested in securing the assistance of the law in the fight against weeds.

THE RUSSIAN thistle is the subject of a bulletin by E. O. Wooton (N. M., no. 16). A general account is given. It was introduced into New Mexico in 1894 at Santa Fe. A revised edition of the circular on the Russian thistle by L. H. Dewey has been sent out by the U. S. Department of Agriculture.

THE ABRASION of tree trunks by snow and sleet driven by the wind was observed by Mr. P. M. Van Epps (*Science* **3**: 442) in a forest in New York. The bark was worn away on the westward side to the height of three or four feet above the surface of the snow, the freshly exposed surfaces giving a conspicuous dull yellow color.

AFTER A critical study of the ligule of Selaginella, Prof. H. Gibson, of University College, Liverpool, decides that the ligule is a specialized ramentum, and bases his conclusions on the very early development of the ligule in the history of the leaf, and the provision for a water supply for the ligule by the arrangement of the vascular bundle. (*Ann. Bot.* March.)—S. C. S.

IN COMMENTING upon Prof. Farlow's article in a recent number of this journal (**20**: 547) on the mimicry of parasitic fungi in insects, Dr. René Ferry (*Rev. Mycol.* **78**: 67) suggests that while insects which mimic healthy leaves receive protection from insect eating foes, those which mimic diseased leaves have an added protection from the incidental injury by leaf-eating enemies.

DR. CORRENS of Tübingen announces his discovery of irritability of tendrils to changes in temperature in the *Botanische Zeitung* for Jan. 16th. This fact, however, was discovered by Prof. D. T. Mac Dougal in the laboratory for plant physiology of Purdue University in November, 1892, and published in this journal (**18**: 125. 1893) together with some results on the chemical irritability of these organs—evidently unknown to Dr. Correns.

AMONG the new African plants discovered by Dr. A. Donaldson Smith are two new genera, *Donaldsonia* Baker, said to suggest technically Pittosporeæ, also showing affinity with Passifloreæ, but not assigned to any family by the author; and *Gillettia* Rendle, belonging to the Commelinaceæ. Both are described and illustrated in *Journ. Bot.* (Feb.). *Baseonema* Schlechter & Rendle is another new African genus, belonging to the Asclepiadaceæ, described and figured in *Journ. Bot.* (March).

SOME interesting records of experiments showing the action of acid potassic oxalate on Elodea and Oxalis, with regard to its effect on the changing of starch to sugar, are given in the March number of the *Annals of Botany.* It is found that a lack of calcium as a counteractant, allows the acid potassic oxalate to prevent the change of starch to sugar, and thus to deprive the plant of all the carbon present in a starch-condition, although the conduction of the other carbohydrates is not interfered with.—S. C. S.

IN AN ILLUSTRATED article in the *Tokyo Bot. Magazine* (**10**: 16–20) Prof. Y. Takahashi shows the identity of *Tilletia oryzæ* Pat. with *Ustilago virens* Cke, a fungus that has recently been demonstrated by Brefeld[1] to be one of the *fungi imperfecti*, and not one of the Ustilagineæ. A new species of Tilletia, *T. horrida*, is described, so far the only genuine Ustilaginea found on Oryza sativa. It is notable for the very long acute spines of the epispore.

BOWER continues his "Studies in the morphology of spore-producing members,"[1] taking up Ophioglossaceæ. His object is "the following out of the probable methods of progression in the evolution of the more complex from the simpler types." The four methods given are septation, branching, reversion of vegetative parts to sporogenous condition, and eruption of appendicular organs from a previously smooth surface. The sporangiophores of Helminthostachys are cited as an example of the last.—S. C. S.

DR. J. E. HUMPHREY, of Johns Hopkins University, gives in the *Annals of Botany* for March, the results of a careful study of all available material on the seed development of the Scitamineæ. He finds "in the characteristic formation of the micropylar collar, in the persistence of the micropylar epidermis over the apex of the embryo-sac, in the very common development of a micropylar aril and in the direct development of the embryo, the features of the seed which are to be regarded as most characteristic of the Scitamineæ;" the genus *Canna* departs sufficiently from these characters to be made the type genus of a distinct family.—S. C. S.

THE *Proc. Philad. Acad.*, 1895, Part III, contains the following material of botanical interest: about 100 new species of fungi, including a new genus (*Stilbomyces*), by Ellis and Everhart; a series of corrections of Mr. W. E. Meehan's determination of his Greenland collection, by Theo. Holm; a second instalment of Professor E. L. Greene's "Eclogæ Botanicæ," in which he describes numerous new western plants and revises the genus *Tropidocarpum;* notes on the study of cross-fertilization of flowers by insects, by Ida A. Keller, which is simply a résumé of the subject, and in which we would suggest the substitution of "pollination" for "fertilization."

PROFESSOR STRASBURGER, in his *résumé* of recent work in vegetable cytology, discusses the behavior and function of the nucleolus during karyokinesis, and confirms the statements of other observers as to its

[1] Unters. a. d. Gesammtgeb. d. Myk. Heft. XII, 1895.
[1] Proc. Roy. Soc. 59: —.

frequent fragmentation and partial distribution in the cytoplasm at that period. He suggests that it provides the material for the construction of the achromatic spindle. This body he considers to consist of two parts, a central strand of unbrcken fibers, which stretch from pole to pole, and along which the chromosomes slide, and an outer group of fibers, which end at the equator on the chromosomes themselves. These latter fibers are effective in conveying the daughter-chromosomes to their respectives poles.—*Jour. Roy. Micr. Soc.* (Feb.).

Mr. George Massee, in *Kew Bulletin* (Jan.) describes and figures *Rosellinia radiciperda*, a new and very destructive root-fungus of New Zealand. It seems to be almost omnivorous in its ravages, attacking all common orchard trees, cabbages, potatoes, etc. It is most plentiful "on the skirts of the primeval forests and on fern lands adjoining where no cultivation has ever been resorted to. Whole crops of potatoes are destroyed on such lands, and on dry lands where native tree stumps remain it is very prevalent." It seems that fungus pests are far more dreaded in New Zealand than any ravages by insects. The new fungus resembles *Dematophora necatrix*, the form producing the root-disease well-known as "pourridié" in central and western Europe.

Mr. Walter Deane has in preparation a flora of the extensive system of metropolitan parks in Boston and vicinity. It will make a volume of about 150 pages, of which more than half are already printed (Apr. 15). This system of parks, created by the Massachusetts legislature and under the control of a special commission, is the most extensive of any in the world. The Arnold Arboretum is included in the system. Several millions have already been expended in improving them, and the work, though only well begun, is being prosecuted with vigor. It is well to have an available flora of these districtss, and Mr. Deane's thorough acquaintance with the seed plants of the region fits him well for the task.

Mr. D. T. MacDougal has been studying the root-tubers of *Isopyrum biternatum* from a physiological standpoint, his results being published as a reprint (March 31) in the advance of the *Minn Bot. Studies.* He finds that the tubers are formed by an excessive development of the pericycle; that the feeble mechanical elements in elongated tubers are compensated for by the habit of penetrating a loose substratum; that the product of photosyntax is probably cane-sugar, which finally accumulates in the tubers in the same form; that the tendency to form "red starch" is characteristic; that the tendency to form tubers is firmly fixed, resisting even in an apparently starving condition in water cultu es; and that the sap of the external tissues contains a bitter substance, which may serve as protection against animals and fungi.

Two recent contributions from Professor R. A. Harper in *Ber. d. deut. bot. Gesell.* present some of the results of his studies among the Ascomycetes. One contribution records observations on the development of the perithecium in *Sphærotheca Castagnei*, in which the author has succeeded in following the whole process of sex-reproduction, a result which goes far towards settling this disputed question among Ascomycetes. Branches develop from neighboring filaments, one of which produces an oogonium, the other an antheridium. The latter becomes curved and closely applied to the former; the walls at the point of contact are absorbed; and the two gametes fuse. The subsequent part played by the basal cell of the oogonium in the construction of the perithecium, and the development of the asci and their spores, are fully described. The other paper is a contribution to nuclear division and spore-formation in as ascus, *Peziza Stevensoniana* and *Ascobolus furfuraceus* having been used.

At the meeting of the Academy of Science of St. Louis, on March 16th, Dr. Wm. Trelease presented some of the results of a recent study of the poplars of North America, made by him for the Systematic Botany of North America, and exhibited specimens of the several species and recognized varieties. Specimens were also exhibited of an apparently undescribed poplar from the mountains of northern Mexico, which he proposed to characterize shortly, and, for comparison, specimens of the two other species of poplar known to occur in Mexico, and of the European allies of the supposed new species, were laid before the Academy. The paper was discussed by Drs. Green, Glatfelter, and Kinner, Mr. Winslow, and Professor Kinealy.

The Academy, in cooperation with the joint committee of the scientific societies of Washington, adopted resolutions favoring the appointment of a permanent chief for the scientific work of the United States Department of Agriculture.

S. Nawaschin is rapidly adding to the list of chalazogamic forms. In *Bot. Centralbl.* (**63**: 353) he gives an account of the discovery of chalazogamy in *Juglans regia*, which shows several peculiar features. The single ovule completely fills the ovary cavity, there being also a wing-like outgrowth on each side of the placenta. The pollen-tube does not even enter the stylar canal or any cavity whatsoever, but advances in intercellular fashion down the style and ovary wall until the placental outgrowths are reached, through which an intercellular passage is effected to the chalaza, through the nucellus, and so to the embryo-sac. The pollen-tube is said to branch freely, so that the tissue of the nucellus seems veined by tubes surrounding the embryo-sac on all sides. The author detected the male pronuclei within the embryo-sac, which he describes as wandering through the protoplasm of the embryo-sac until they meet and coalesce with one of the several free nuclei which function as oospheres but have not been differentiated into an "egg-apparatus."

The following experiment station bulletins, recently published, pertain to vegetable pathology: Spraying experiments in 1895, by H. Garman (Ky., no. 59) gave favorable results with Bordeaux mixture on apples, and negative results with iron sulphate; Spraying orchards and vineyards, by J. C. Whitten (Mo., no. 31) reports favorable results with Bordeaux mixture; Experiments in the treatment of peach rot and of apple scab, by F. D. Chester (Del., no. 29) reports favorable results with several copper compounds; The smut of oats and its prevention, by Aug. D. Selby (Ohio, no. 64) gives a good general account of the disease, and favorable results with use of hot water and potassium sulphite; Treatment of some fungous diseases, by L. M. Underwood and F. S. Earle (Ala., no. 69) gives a general account of the most prominent plant diseases, and their treatment; Bacteriosis of carnations, by J. C. Arthur (Ind., no. 59) reports the results of an extended study of the disease, with methods of treatment; Field experiments with potatoes, by B. D. Halsted (N. J., no. 112) reports favorable treatment of potato scab and sweet potato rot with lime, sulphur, corrosive sublimate and sulphate of copper; Diseases of the potato, by E. G. Lodeman (Cornell, no. 113) treats of early and late blight, scab, and beetles. There are evidences of hasty preparation in this bulletin, and some errors of statement have crept in, for instance, the description of oospores in Phytophthora infestans, although no such structures have yet been discovered.

BOTANICAL GAZETTE

MAY, 1896.

Filices Mexicanæ. VI.

Ferns collected in the states of Oaxaca, Morelos and Vera Cruz, Mexico, during the seasons of 1894 and 1895, by C. G. Pringle, of Charlotte, Vermont.

GEORGE E. DAVENPORT.

WITH PLATE XVIII.

ACROSTICHUM CONFORME Swartz.

4916, cold summit ledges, Sierra de San Felipe, Oaxaca, Sept. 19, 1894, 10,300^{ft} alt.

ACROSTICHUM PILOSUM HBK.

5583, cliffs, Orizaba, Vera Cruz, Jan. 24, 1895.

Acrostichum Pringlei, n. sp.

Plant 5 to 8^{in} or more tall: rhizome short-creeping, clothed with blackish brown closely appressed fibrillose scales: stipes straw-colored, those of the sterile fronds 1 to 4^{in}, of the fertile 5 to 7^{in} long, deciduously chaffy and scaly with pale brown minute scales mixed with darker reddish brown slightly ciliated or toothed scales at the base: sterile and fertile laminæ similar, 2 to 2.5^{in} long, $\frac{3}{8}$ to $\frac{5}{8}$ broad, oblong or elliptic lanceolate, obtusely rounded or sub-acute at the apex, the base cuneate, both surfaces rusty puberulent with more or less deciduous chaff, margins fringed with short cilia, texture sub-coriaceous, veins close, indistinct, forked once or twice, the thickened tips of the veinlets reaching to the edge.—5605, cold summit ledges, Sierra de San Felipe, 10,000^{ft}, Sept. 25, 1894.

I am indebted to Mr. Baker for the determination of this fern, which appears to be intermediate between *A. Lindeni* and *A. Lloense*, and I should have dedicated it to him if his name had not been preoccupied in this genus.

ACROSTICHUM SPATHULATUM Bory.

4964, mossy banks, Sierra de San Felipe, 7,300ft, Oct. 6, 1894.

ASPIDIUM ACULEATUM Swartz.

5588, hills near Orizaba, Feb. 9, 1895. 5603, wet ravines, Sierra de San Felipe, 9,000ft, Nov. 21, 1894. 6116, moist ravines, Sierra de San Felipe, 8,000ft, Dec. 26, 1894.

Nowhere, does it seem to me, was the rare discriminating judgment of Sir William Jackson Hooker more clearly shown than in his disposition of the various forms of this protean species.

In a species so widely distributed as this, inhabiting, as it does, "almost every part of the known world", as extended a range of forms is to be expected, and it is not surprising that many supposed species should have originated from them. One can not, however, examine a great many of these forms, in the light of our present knowledge of the species, without becoming impressed with the fact that a certain type runs through the whole series, and that they all group themselves naturally around two forms, or types, which seem worthy of recognition.

One of these has the lower pinnæ reduced as in our var. *Braunii*, and of these *lobatum* is the type; the other has a broad base, and of this *angulare* furnishes the best type.

It is to be observed, however, that in the first type the lower pinnæ never dwindle away to mere auricles as in the *conterminum* and *Noveboracense* group of Nephrodium, but always preserve a certain breadth and distinctness as pinnæ.

Mr. Pringle's numbers represent the two types, his 5588 having the lower pinnæ reduced as in *lobatum*, but otherwise having the characters of *A. Moritzianum* (which Fournier keeps distinct), while his 6116 has the broad base of *angulare* and the vestiture of *A. venustum* Swz. mixed with the beautiful glossy black scales peculiar to the "New Holland, New Zealand and southern antarctic" forms of the species. (Sp. Fil. 4: 22.) 5603 has a thinner, more herbaceous texture and fewer sori, due probably to the character of its environment.

ASPIDIUM ATHYRIOIDES Mart. & Gal.

Athyrium sphaerocarpum Fée.
Nephrodium sphaerocarpum Hk.

6190, shaded banks above Cuernavaca, 5,500ft. Nov. 22, 1895.

Fée's name for this fern is the oldest, and is the one used by Hooker in *Species Filicum*, and Mr. Baker in *Synopsis Filicum*, and if the species is to be maintained should be the one used.

I am, however, averse to having my own name attached to it under Aspidium, and the more particularly so as I look upon it as a mere form of *A. patulum* Swz. (*N. Mexicanum* Hk.), a species which, the more I see of it, I am convinced is as variable and prolific of forms as our own *A. spinulosum*.

ASPIDIUM FILIX-MAS Swartz, var. PARALLELOGRAMMUM Hk.

A. parallelogrammum Kze.

5965, ravines, Sierra de San Felipe, Dec. 12, 1895.

Fournier keeps this distinct as a species, but the large series of specimens that I have examined incline me to accept Hooker's disposition of it. It is, however, certainly distinct enough from ordinary *filix-mas* to make a very good variety.

ASPIDIUM JUGLANDIFOLIUM Kze.

5585, shaded banks, Orizaba, Jan. 15, 1895.

ASPIDIUM PATULUM Swartz.

Nephrodium Mexicanum Hk.

Var. CHAEROPHYLLOIDES Baker.

A. chaerophylloides Moritz.

5580, ravines of hills above Orizaba, Feb. 5, 1895.

Aspidium scabriusculum, n. sp.

Rootstock shaggy, especially at the crown, with long pale brown silky fibrillose scales that envelop the base of the stipes: fronds 2 to 5ft tall; stipites 10 to 18in long, chestnut-brown below, gradually becoming stramineous above, channelled, scabrous on the angles, deciduously fibrillose and clothed with small appressed dark scales: laminæ deltoid, 1 to 4ft each way, bi-pinnatifid above to tripinnate below, apices acuminate; pinnæ petiolate, the middle and upper ones nearly equal sided, with pinnules 1 to 2in long, $\frac{1}{2}$in broad, and sub-falcate mostly entire segments; lowermost pair unequal-sided 1 to 2ft long, 9 to 18in broad at base, lower pinnules longest, the basal one 6 to 12in long, 2 to 5in broad at base, tertiary divisions cut to a winged rachis into close sub-falcate pinnatifid or entire segments, the lower ones often distinct; rachises furrowed, scabrous, densely paleaceous throughout with deciduous chaff intermixed with minute appressed persistent dark scales; texture herbaceous, surfaces naked, or minutely pilose above along the veins, veinlets simple, or in immature segments appearing forked: sori medial, indusia fugacious, disappearing early.—6132, shaded banks of cañon near Orizaba, 4,500^{ft}, Feb. 6, 1895.

A magnificent fern about which I do not even yet feel positive; but as I have been unable to place it satisfactorily, and as my good friend Prof. Underwood thinks it new, I hazard its publication. It seems strange, however, as Mr. Pringle remarks, that a fern of its proportions should have escaped the attention of other collectors who have collected in the vicinity of Orizaba.

It comes very near Mr. Baker's *Nephrodium intermedium*, some specimens of which at Cambridge closely resemble the smaller specimens of Mr. Pringle's plant.

The following synonyms may serve for those who prefer other generic names: *Nephrodium scabriusculum; Dryopteris scabriuscula; Lastrea scabriuscula.*

Aspidium strigilosum, n. sp.

Rootstock short, sub-erect, roots densely clothed with light brown wool, caudex and base of stipes clothed with long dark brown fibrils: stipes tufted, 4 to 7^{in} long, strongly channeled, light brown, gray when young, scabrous to the touch and fibrillose: laminæ lanceolate, 8 to 11^{in} long, 2.5 to 4^{in} broad at base, narrowing gradually to the acute apex, partially bipinnate below, above pinnate, the apex deeply pinnatifid to the tip; pinnæ stalked (uppermost subsessile or sessile), alternate (lower ones sometimes opposite), distant, lanceolate (reproducing the laminæ in outline), 1.5 to 2^{in} long, $\frac{1}{2}$ to $\frac{5}{8}^{in}$ broad at base; divisions oblong or sub-falcate, incisely toothed or pinnatifid, or nearly entire, lowermost distinct, exterior ones often sharply toothed at the base only on the outside, apices notched, or curved outward to an obtuse point; texture herbaceous, both surfaces finely and glandulosely pubescent, the margins minutely ciliated; rachises throughout strigose and fibrillose; veins simple, sori close to the costa, 3 to 5 or 6 pairs to a pinnule; indusia fugacious.—6077, dry calcareous cliffs, barranca of Metlac, near Orizaba, 3,000 to 3,500^{ft}, Jan. 29, 1895.

Mr. Pringle says of this fern that "it was growing in a peculiar situation, in curious pockets on the face of a cliff of lime rock. I could find no other station, so it must be rare, and may have escaped the notice of earlier explorers of that much traveled region."

Nephrodium strigilosum, Dryopteris strigilosa, or *Lastrea strigilosa* may serve as synonyms for those who reject Aspidium as defined by Swartz.

ASPLENIUM CICUTARIUM Swartz.

6094, mossy calcareous ledges, barranca near Orizaba, 4,000ft, Jan. 21, 1895.

ASPLENIUM ERECTUM Bory, var. PROLIFERUM Hook.

5601, Sierra de San Felipe, 8,000ft, May 22, 1894.

Asplenium fibrillosum Pringle & Davenport, n. sp. *Plate XVIII, figs. 1–4.*

Plant small, 2 to 6in high: rootstocks tufted, erect or decumbent, clothed with blackish brown fibrils: fronds linear, $\frac{3}{8}$ to $\frac{1}{2}$in broad in the middle, pinnate with 8 to 20 pairs of sub-sessile or short-stalked unequal-sided pinnæ, the apex deltoid, three-parted or deeply pinnatifid and obtusely crenate, the lowermost pinnæ reduced and distant: stipe and rachis bronzy brown, deciduously fibrillose throughout, the former $\frac{1}{2}$ to 2in long, the latter not winged but furrowed on the face, and sometimes on both sides, with the furrows extending down the stipe: pinnæ spreading, or deflexed, $\frac{1}{8}$ to $\frac{1}{4}$in broad, nearly as deep, deeply and obtusely crenate, and varying from sub-dimidiate to rhomboidal; texture sub-coriaceous; veins pinnate, sori oblique to the center, usually 2 to 5 to a pinna, *indusia with laciniated margins fringed with long cilia.*—6191, mossy bluff of a barranca above Cuernavaca, Nov. 21, 1895, and reported by Mr. Pringle as probably rare.

This charming new fern, which is to become a member of the Trichomanes group, closely resembles *A. Trichomanes,* for which it might be mistaken without a careful examination. It differs from that species by its fibrillose vestiture and ciliated indusia. The former may not always prove to be reliable as I find that in my largest and oldest frond the stalk and rachis have become quite smooth, thus showing the vestiture to be deciduous. The ciliated indusia, however, appear to be persistent and thus constitute a permanent character.

As the sori mature the indusia turn back, and the long cilia, extending beyond or overlapping the face of the pinnæ, give to them, on holding to the light, the appearance of being beautifully fringed. The normal condition of the rootstock is undoubtedly that of *A. Trichomanes*, but when compressed from growing in tight crevices, it appears to be somewhat creeping as in the figure. Mr. Faxon's drawing admirably shows the essential characters of the species.

ASPLENIUM FRAGRANS Swartz.

5584, growing on trees, Orizaba, Jan. 25, 1895.

ASPLENIUM HASTATUM Klotz.

5582, moist ravines, Orizaba, Jan. 21, 1895.

ASPLENIUM MONANTHEMUM Linn.

5964, Sierra de San Felipe, 10,000^{ft}, Dec. 10, 1895. Specimens pleurosorous above; not an uncommon occurrence in this species.

Asplenium Eatoni, n. sp.

Asplenium cicutarium Swz., var. *paleaceum* Davenport. 5531 of 1893 collection, BOT. GAZ. **19**: 390. 1894.

Rootstock caudiciform and sheathed with the bases of old fronds, scales linear, terminating in long cilia, translucent and appearing as if varnished: stipes 1 to 5^{in} long, fibrillose below and, as well as the main rachis, greenish gray, broadly furrowed or winged on the face, and densely clothed with pale brown chaff: laminæ 6 to 16^{in} long, 2.5 to 5^{in} broad in the middle, narrowing both ways, bipinnate; pinnæ subsessile, spreading, lowermost reduced and deflexed, rachises winged and chaffy; pinnules $\frac{3}{8}$ to $\frac{1}{2}^{in}$ long, $\frac{3}{16}$ to $\frac{1}{4}^{in}$ broad, obliquely ovate oblong with unequally cuneate, or, on the inner side, truncate bases, and pinnatifidly cleft into sharply toothed lobes, *the teeth cartilaginous;* texture herbaceous, veins flabellately forked, veinlets entering the lobes, sori large, variously disposed, 1 to 3 to a pinnule.—6072, 5602, wet cañons and ravines, Sierra de San Felipe, 8,500 to 9,000^{ft}, Nov. and Dec., 1894.—Dedicated to the late Prof. Daniel Cady Eaton.

This fern which, after consultation with Prof. Eaton, I published in the BOTANICAL GAZETTE for October, 1894, as a variety of *A. cicutarium*, now proves to be quite distinct from that species. Prof. Eaton, as well as I, thought that this would eventually be the case, but as the material then in hand did not warrant the step I have now taken it was deemed best to put it under *A. cicutarium* as a possible variety of that species to which it is closely related. It is one of the most elegant of the Asplenia, the rich furfuraceous vestiture of the frond giving to it a peculiar charm, while that character and the *cartilaginous teeth* clearly separate it specifically from *A. cicutarium.*

I have long wished for an opportunity to dedicate some suitable fern to Prof. Eaton who rendered such splendid service to American pteridology, and to whose many kindnesses and courtesies I have personally been so greatly indebted, and I have taken advantage of the pre-occupation of its varietal name in this genus to name for him a fern as beautiful as was his own soul.

ASPLENIUM SERRA L. & F.

5597, on trees, hills above Orizaba, Feb. 6, 1895.

CHEILANTHES AURANTIACA Moore.

C. ochracea Hook.
Pteris lutea Cav.

6192. A rare fern, seldom collected. Neither the description in *Sp.* nor *Syn. Fil.* accurately describes Mr. Pringle's specimens, but Hooker's figure in Ic. Plant. *pl. 904*, leaves no doubt as to their identity.

CYATHEA SCHANSCHIN Mart.

6088, wooded hills above Orizaba, 4,300^{ft}, Jan. 26, 1895. My specimen represents a single pinna only from a plant with "stalks 10^{ft} tall and fronds (lamina) 5 to 8^{ft} long."

GLEICHENIA LONGISSIMA Bl.

6076, wooded ravines, Orizaba, 4,300^{ft}, Jan. 26, 1895. Pinnæ 3–4^{ft} long.

GLEICHENIA PUBESCENS HBK.

6129, 6130, the first a smoothish form, damp banks of soil near Orizaba, 4,300^{ft}, Feb. 7, 1895. Plants 2 to 5^{ft} high.

GYMNOGRAMME CALOMELANOS Klf.

Calcareous bluffs, 4,000^{ft} alt., near Orizaba, Jan. 24, 1895.

HYMENOPHYLLUM AXILLARE Swz.

5592, on trees, Orizaba, Feb. 7, 1895.

HYMENOPHYLLUM HIRSUTUM Swz.

6079, shaded cliffs of hills above Orizaba, Jan. 25, 1895.

HYMENOPHYLLUM LINEARE Swz.

5591, shaded cliffs near Orizaba, Feb. 6, 1895.

HYMENOPHYLLUM POLYANTHOS Swz.

5590, with 5591, Jan. 25, 1895.

I am greatly indebted to Mr. Baker for his kindly assistance in determining these Hymenophyllums.

LOMARIA ATTENUATA Willd.

4999, by brooks, Sierra de Clavellinas, 9,000^{ft} alt., Oaxaca, Oct. 16, 1894.

LOMARIA PROCERA Spreng.

5581, from Orizaba, Feb. 3, 1895, with abnormally pinnatifid pinnæ, agrees with the "forma-monstrosa" of *L. falcata* from Australia in the Cambridge herb. (no. 652), otherwise with *L. varians* Fourn., and Liebmann's *L. spectabilis* both from Orizaba and clearly identical with Mr. Pringle's plant.

5599, from "springy places" Sierra de Clavellinas, 9,000^{ft} alt. Oct. 25, 1894, has the form and texture of *L. Capensis* (L.) Willd. But here again we have a species with widely extended range and a great variety of forms that have given rise to a number of untenable species by different authors.

Dr. Hooker (Fl. of N. Zealand **2:** 28) declared that there were "no limits to the variation of this protean plant," and that it was only by large suites of specimens with stipes and rhizome that an accurate idea could be obtained of such species, it being "impossible for the student, or even the botanist, to recognize some states of this plant at first sight."

Osmunda Capensis Linn., founded on a south African plant, is the oldest name, and if strict priority for the specific name under all changes should prevail, Willdenow's combination would take precedence, although it can scarcely be doubted that the species as at present understood is very different from what it was when first established.

MARATTIA LAXA Kze.

5593, woods, Orizaba, Feb. 5, 1895. I do not feel fully satisfied with this determination, but as Prof. Underwood agrees with me in referring the specimen to this species, and Fournier gives it as from Orizaba, it is perhaps as well to leave it here until fuller material confirms or displaces it.

NOTHOLAENA HOOKERI D. C. Eaton.

5606, calcareous bank, La Hoya cañon, Nov. 2, 1894.

PELLAEA CORDATA J. Smith, f. *sagittata*.

Pteris sagittata Cav.

Pellaea sagittata Link.

4887, dry banks and ledges, Sierra de San Felipe, 7,500[ft], Sept. 11, 1894.

J. Smith regarded both forms as distinct species, and they are still so considered by some authors. Fournier gave the present form as a variety, while in *Synopsis Filicum* it is put under *cordata* without any recognition of varietal characters. I am myself unable to see any other difference between them than in the mere shape of the pinnules, these in the type being ovate-cordate or, as in Mr. Pringle's 1885 specimens, no. 448, even heart-shaped, while in the present form they are twice the length and oblong-cordate, or sagittate; but these are extremely variable characters, and at the best only varietal. I have elsewhere (Bulletin Torrey Bot. Club **13:** 133–135) pointed out the structural differences in the root-stock of *P. cordata* and *P. intermedia* Mett., that separate those two ferns specifically.

With other specimens in Mr. Pringle's collection there are two fronds only of a fern so different from any heretofore described, or known to me, that I do not hesitate to publish it as new, notwithstanding the meagerness of the material at present in hand. Not only is it specifically distinct, but its special and peculiarly distinctive character is not found in any described genus. Its natural affinities otherwise, however, are so clearly with *Pellaea* that I do not think it would be wise to separate it from that genus even though it be true that genera have been created out of still more meager material and less distinctive characters than this fern possesses. At the same time believing that it is entitled to something more than specific recognition I propose for it a new section under Pellaea to be called HYMENOLOMA, from *hymen*, membrane, and *loma*, a border or margin, and characterized by having the *margin of the lamina throughout reflexed and membraneous*. Secondary characters may be found in the venation and sori, the former being simpler, coarser and merely pinnated with distant branches, and the latter not being confluent, but having each sorus round and distinct.

This new section may very properly precede CHEILOPLECTON (Fée) on account of its simpler venation, and will be represented by the following species:

Pellaea (Hymenoloma) **membranacea,** n. sp. *Plate XVIII, figs. 5, 6.*

Rootstock not seen, but probably rhizomataceous with distinct fronds 2 to 3^{ft} high: stipes (in the specimens) 20^{in} tall, and, as well as the primary and lower half of the secondary rachises, naked, bright red, polished and furrowed on the face: lamina 12^{in} long, nearly as broad at base, ovate-deltoid, bi- to tripinnate above, tri- to quadripinnate below, the acute apex, as well as the apices of pinnæ and pinnules, deeply pinnatifid; pinnæ suberect, unequal-sided, stalked, lower pair much the largest and deltoid-ovate with ovate lanceolate stalked pinnules $1\frac{1}{2}$ to 3^{in} long (in the lower series), $\frac{3}{4}$ to 1^{in} broad; pinnules pinnate, the divisions again pinnated below, or obliquely cleft throughout into linear-oblong, cuneate or obovate crenate segments; texture firm herbaceous, surfaces naked, or minutely glandular above, the changed margins reflexed and forming a *membranous border all round the divisions and winged rachises of the pinnules, the edge irregularly laciniate or fringed with stalked glands;* veins obscure, except in a strong light when they are seen to be simply pinnate, the distant alternate branches terminating in the sinuses of the segments, and when soriferous bearing a single small round sorus at the end: *sori not confluent:* involucres broad, overlapping to the center before maturing, and consisting of a part of the *membranous margin of the lamina.*—5963, ravines, Sierra de San Felipe, Dec. 10, 1895.

Mr. Pringle writes that he first saw the fern growing in moist cañons high up in the Sierra de Oaxaca in the spring of 1894, but that then the plants were too young to collect. He did not return later for it "partly because other plants crowded upon me, and partly because I feared it might prove only a form of *Pellaea marginata.* Last December, however, when I was on the same mountains I came upon a plant that had not died down and took two fronds in order to find out what it might be."

The fact that in these two late fronds the sori are distinct tends to show that they are never confluent as in other Pellaeae. As Mr. Pringle expects to return to San Felipe, where he says this fern is not scarce, he will no doubt have specimens of it for distribution another year.

Pellaea Pringlei Davenport.

7081, wet cliffs, near Cuernavaca, Morelos, Nov. 21, 1895.

PHEGOPTERIS RUDIS Mett.

5598, hills above Orizaba, Feb. 3, 1895. 5600, Sierra de San Felipe, May 31, 1894.

Specimens much larger than previously recorded.

POLYPODIUM ANGUSTIFOLIUM Swz.

5596, Sierra de San Felipe, 8,000ft, May 22, 1894.

POLYPODIUM ANGUSTUM Mett.

5587, on trees, hills of Orizaba, Feb. 9, 1895.

This is a very strange plant, some states of which it is very difficult to recognize, and even the ordinary forms, with their twisted narrowly linear divisions and large sori, look more like abnormal than normal growths.

POLYPODIUM FALLAX Schl.

6124, on shrubs near Orizaba, 4,300ft, Feb. 5, 1895.

POLYPODIUM FRATERNUM C. & S.

5595, on oaks, hills of Orizaba, Jan. 20, 1895.

POLYPODIUM LORICEUM L.

6083, on trees, hills above Orizaba, 4,300ft, Jan. 25, 1895.

Specimen exactly matches Bourgeau's specimen of *P. falcaria* Kze., at Cambridge, 3187, from San Christabel, Mexico, also Wright's 827 from Cuba, 1856–57.

POLYPODIUM MARTENSII Mett.

4917, on trees and ledges, Sierra de San Felipe, 10,000ft, Sept. 26, 1894.

POLYPODIUM MONILIFORME Lag.

5604, from cold summit ledges, Sierra de San Felipe, 10,400ft, Sept. 10, 1894; 6194, do., Dec. 13, 1895.

POLYPODIUM PLECTOLEPIS Hk.

5589, hills near Orizaba, Feb. 3, 1895.

POLYPODIUM REPENS L.

6082, shaded ledges near Orizaba.

This species appears to run into *P. phyllitidis* and it is almost impossible at times to tell one from the other. They seem to me to be very doubtfully distinct.

POLYPODIUM REPTANS Swartz.

5594, base of calcareous cliffs, barranca of Metlac, Jan. 29, 1895.

This fern has gravitated back and forth between Phegopteris and Polypodium according to the views of different authors. Mettenius referred it to Aspidium, crediting it with the presence of a delicate fugacious indusium in its early states, but I have been unable to find any trace of an indusium in my own specimens, or any that I have examined, and some of them are of just the right age to show an indusium if any existed. Prof. Eaton referred it to Phegopteris, and it is true that it has the aspect of a Phegopteris, but no more so than some other Polypodiums with similar texture and pubescence.

It is extremely doubtful if Fée would have admitted ferns with anastomosing venation, even though the veins in very young fronds were free, under Phegopteris, or that Presl would have recognized under it his Goniopteris.

POLYPODIUM SQUAMATUM L.

5586, hills near Orizaba, Feb., 1895.

PTERIS PODOPHYLLA Swz.

6123, wooded hills above Orizaba, 4,300^{ft}, Feb. 3, 1895. Plants 3 to 5^{ft}.

TRICHOMANES RADICANS Swz.

4677, wet ledges, Sierra de San Felipe, 8,000^{ft}, May 31, 1894. Specimens unusually large and fine.

VITTARIA LINEATA Smith.

5579, hanging from trees in ravine above Orizaba, Feb. 5, 1895.

Medford, Mass.

Addendum.

ASPLENIUM DUBIOSUM Davenport.

This fern, which was first collected by Mr. Pringle in 1887, was referred to *A. pumilum* with some hesitation in my notes on his collection for that year in the *Bulletin* of the *Torrey Botanical Club* **15:** 226. In *Garden and Forest* for October, 1891 I published it as new under the above name. In the *Annals of Botany* **5:** 305–6. Ag. 1891, it was published by Mr. Baker as a new species from specimens received through Mr. Pringle's distribution, and as his name necessarily supersedes my own the species hereafter will be known as *Asplen-*

ium Chihuahuaense Baker. Mr. Pringle's number, however, should be 1444, instead of 144 as given in the *Annals of Botany*, probably through an error in proof-reading.

EXPLANATION OF PLATE XVIII.

Asplenium fibrillosum Pring. & Dav.—Fig. 1. Plant, showing fibrillose vestiture.—Fig. 2. Enlarged pinna, upper side.—Fig. 3. Enlarged pinna, under side.—Fig. 4. Enlarged indusium showing ciliated margin.

Pellæa membranacea Dav.—Fig. 5. Enlarged pinnule showing membranous border of the lamina.—Fig. 6. Enlarged segment with involucre turned back showing jagged edges, venation and sori.

Flowers and insects. XVI.[1]

CHARLES ROBERTSON.

NOTHOSCORDUM STRIATUM Kunth. *N. ornithogaloides* (Walt.) Kunth.—The plant is common in woods, blooming from April 10th to May 16th. The scapes grow 1 or 2^{dm} high and bear small umbels of white flowers. The flowers are about 10^{mm} long and expand 10 or 12^{mm}. The sepals are approximated below, the base of the tube being greenish and narrowed by the ovary and the filaments of the six stamens. The flowers are homogamous, the stigma occupying the center of the circle of anthers and somewhat surpassing them. Spontaneous self-pollination can hardly occur.

The flower is remarkable for being abundantly visited by numerous species of bees of the genus *Nomada*. On seven days, between April 20th and May 9th, I captured the following visitors:

HYMENOPTERA—*Apidæ:* (1) Nomada luteoloides Rob. ♂; (2) N. superba Cr. ♂, freq.; (3) N. americana Kby. ♂; (4) N. maculata Cr. ♂♀, ab.; (5) N. cressonii Rob. ♂♀, ab.; (6) N. sayi Rob. ♂♀, freq.; *Andrenidæ:* (7) Augochlora similis Rob. ♀, ab.; (8) Halictus confusus Sm. ♀, s. and c. p.; (9) Andrena sp. ♀, s. and c. p., freq.

DIPTERA—*Syrphidæ:* (10) Mesograpta marginata Say; (11) Sphaerophoria cylindrica Say, ab.

LEPIDOPTERA—*Rhopalocera:* (12) Colias philodice Gdt.; (13) Pieris rapæ L.; (14) Lycaena comyntas Gdt.; *Heterocera:* (15) Plusia simplex Gn.—All only sucking, except (8) and (9).

CAMASSIA FRASERI (A. Gray) Torr.—The flower is described and figured by Loew (2) from material growing in the Berlin Garden. According to his account, the inflorescence consists of a long loose raceme of twenty or more flowers. The flowers are directed obliquely upwards and have widely expanded sepals. The anther faces are directed forwards so as to touch the visitors, and the stigma is about 4^{mm} in advance of them. Nectar is secreted by septal glands and collects under the base of the ovary.

Loew (1) saw the flowers visited by *Apis mellifica* and *Osmia rufiventris*. He, however, does not consider them to be adapted to these middle-sized bees, but to Lepidoptera, which

[1] Contributions to an account of the ecological relations of the entomophilous flora and the anthophilous insect fauna of the neighborhood of Carlinville, Illinois.

he supposes may hover in front of the flower in such a way as to come in contact with the anthers and stigma.

The flowers described by him are certainly larger than any I have seen. When watching the flowers being visited by bees and Syrphidæ, it did not occur to me that there was any difficulty in their effecting pollination, though the smallest might obtain the nectar without often touching anthers or stigma. I see nothing about the flower to indicate an adaptation to insects with long tongues or to those of large size.

About Carlinville, the plants are common, sometimes being collected in quite conspicuous patches, which are very attractive to insects. The blooming time is from April 25th to May 16th. The scapes rise from 3 to 6^{dm} high. The flowers are pale blue, or sometimes white. The sepals expand widely, to the extent of two or more cm. The stigma is receptive with, or a little in advance of, the dehiscence of the anthers. The stamens, however, are so strongly divergent that insects may easily touch the stigma before coming in contact with them. The flowers are evidently adapted to bees, but are visited by flies and other insects. On the morning of May 8th, in about an hour, I captured the following visitors:

HYMENOPTERA—*Apidæ:* (1) Apis mellifica L. ☿, s., ab.; (2) Bombus americanorum F. ♀, s., one; (3) Synhalonia frater Cr. ♂♀, s., freq.; (4) S. belfragei Cr. ♂, s.; (5) Ceratina tejonensis Cr. ♂, s.; (6) C. dupla Say ♂, s.; (7) Osmia albiventris Cr. ♂♀, s. & c. p.; (8) Nomada superba Cr. ♂♀, s., freq.; (9) N. americana Kby. ♂, s.; *Andrenidæ:* (10) Halictus pectoralis Sm. ♀, s., freq.; (11) H. forbesii Rob. ♀, s.; (12) H. lerouxii Lep. ♀, s. & c. p.; (13) H. ligatus Say ♀, s. & c. p.; (14) H. fasciatus Nyl. ♀, s. & c. p., ab.; (15) H. pilosus Sm. ♀, s. & c. p., ab.; (16) H. confusus Sm. ♀, s. & c. p., freq.; (17) H. pruinosus Rob. ♀, s. & c. p., freq.; (18) Augochlora pura Say ♀, s.; (19) A. similis Rob. ♀, s.; (20) Agapostemon viridula F. ♀, s.; *Vespidæ:* (21) Polistes pallipes Lep., s.; *Eumenidæ:* (22) Odynerus tigris Sauss., s.

DIPTERA—*Syrphidæ:* (23) Chrysogaster pictipennis Lw.; (24) C. nitida Wd.; (25) Eristalis dimidiatus Wd.; (26) Syritta pipiens L.; *Tachinidæ:* (27) Micropalpus fulgens Mg.; *Sarcophagidæ:* (28) Cynomyia mortuorum L.; (29) Helicobia helicis Twns.; *Muscidæ:* (30) Lucilia cornicina F.; (31) L. caesar L.; *Anthomyidæ:* (32) Phorbia acra Wlk.; (33) P. fusciceps Zett.—all s.

LEPIDOPTERA—*Rhopalocera:* (34) Pyrameis atalanta L.; (35) P. huntera F.; (36) Colias philodice Gdt., freq.—all s.

COLEOPTERA—*Coccinellidæ:* (37) Hippodamea 15-maculata Muls., s.

On the literature of *Camassia* see:

(1) Loew, Beobachtungen über Blumenbesuch von Insekten an Freilandpflanzen des Botanischen Gartens zu Berlin. Jahrb. Bot. Gartens Berlin **3**: 82, 117. (14, 49) 1884.—(2) Loew, Blüthenbiologische Beiträge, II. Pringsheim's Jahrbücher **23**: 76–77. 1892.

POLYGONATUM Adans.—This genus contains perennial herbs with pendulous, tubular bell-shaped, greenish flowers, which are homogamous, adapted to bumble-bees, or other long-tongued bees, though sometimes also visited by Lepidoptera and small insects which crawl into the tube. Self-pollination, as well as cross-pollination, may be effected by insects, or in some cases spontaneous self-pollination may occur by the anthers coming in contact with the stigma. That nectar is secreted by the ovary was known to Sprengel (1), while Bonnier (2) and Grassmann (7) have indicated the presence of septal glands.

We may suppose that the pendulous position of the flowers owes its origin to the fact that it renders them less convenient to other insects, but equally convenient to the higher bees, which are the most efficient pollinators; and that the resulting protection to pollen and nectar is merely an incidental effect.

On the theory that the flowers are adapted to bumble-bees, it is hard to understand the observation of Schulz (14) that the flowers of *P. verticillatum*, *multiflorum* and *officinale* are frequently perforated by them. In the case of the short-tongued species, like *B. terrestris*, we may suppose that the perforation is made because the bee cannot reach the nectar in the legitimate way. In the case of *P. verticillatum* the larger buds were also perforated. If the three species have nectar secreted prematurely in the bud, we might explain the behavior of the long-tongues by supposing that they have discovered this and cut through the tube without taking the trouble to find out whether the mouth is open or not.

POLYGONATUM GIGANTEUM Diet. *P. biflorum commutatum* (R. & S.) Morong.—The tube measures about 17^{mm} long and expands about 5^{mm} at the throat. The latter is obstructed by the filaments, which are inserted on the middle of the tube and are inclined inwards. The style is so short that, owing to the position of the flower, spontaneous self-pollination is impossible, though insects may with their proboscides carry pollen back to the stigma of the same flower. The flowers bloom from the 17th of May to the 14th of June. On May 23rd, 27th and June 1st I saw them visited by:

Apidæ: (1) Bombus vagans Sm. ♀, s. & c. p.; (2) Anthophora ursina Cr. ♀, s. & c. p.; (3) A. abrupta Say ♀, s. & c. p.

On the literature of *Polygonatum* see:

(1) Sprengel, Das entdeckte Geheimniss 198–9. 1793. *Convallaria polygonatum, multiflora.*—(2) Bonnier, Les Nectaires 23, 36, 86, 136,

192. 1879. *P. vulgare, multiflorum.*—(3) Müller, Alpenblumen 52–4. 1881. *C. polygonatum, verticillata.*—(4) Müller, Die Entwickelung der Blumenthätigkeit der Insekten. Kosmos **9**: 208. 1882. *C. polygonatum.*—(5) Durand, Sur quelques particularités d' organisation de la fleur des Polygonatum. Bull. mens. Soc. Linn. Paris **1882**: 322–3. (Just **10**²: 75).—(6) Loew, Blumenbesuch von Insekten an Freilandpflanzen. Jahrb. Bot. Gartens Berlin **3**: 99 (31) 1884. *P. officinale.*—(7) Grassmann, Die Septaldrüsen. Flora **67**: 118, 135. 1884. *P. officinale, multiflorum, verticillatum.*—(8) Engler, Liliaceæ. Engler u. Prantl, Die natürlichen Pflanzenfamilien 2: 15–16. 1887. (Just **16**¹: 555).—(9) Jordan, Beiträge zur physiol. Organographie der Blumen. Ber. der Deut. Bot. Ges. **5**: 330. 1887. *P. latifolium.* (Loew, Floristik 350).—(10) Pammel, On the pollination of Phlomis tuberosa and the perforation of flowers. Trans. St. Louis Acad. Sci. **5**: 254, 273. 1888. *C. polygonatum.*—(11) Kirchner, Flora von Stuttgart und Umgebung 70. 1888. *P. verticillatum.*—(12) Almquist, Om honings gropens s. k. fjäll hos Ranunculus och om honing salstringen hos Convallaria polygonatum och multiflora. Bot. Notiser **1889**: 66. (Just 16¹: 533).—(13) Almquist, Ueber Honigerzeugung bei Convallaria polygonatum und multiflora. Bot. Centralb. **38**: 663. 1889. (Just 17¹: 505).—(14) Schulz, Beiträge zur Kenntniss der Bestäubungseinrichtungen und Geschlechtsvertheilung bei den Pflanzen 2: 166, 224. Bibliotheca Botanica 17: —. 1890. (Just **18**¹: 524).—(15) MacLeod, Over de bevruchting der bloemen in het Kempisch gedeelte van Vlaanderen. Bot. Jaarboek **5**: 311–13. 1893. *P. multiflorum.*—(16) Loew, Blütenbiologische Floristik. 166, 350. 1894. *P. multiflorum, verticillatum, latifolium, officinale.*

SMILACINA STELLATA Desf. *Vagnera stellata* (L.) Morong.—This plant occurs on rich banks, sometimes forming rather large patches. It grows 4 or 5^{dm} high and bears a small terminal raceme of white flowers. The stem is bent to one side so that the axis of the raceme is directed horizontally. The flowers are arranged on the upper side so that the sepals are expanded horizontally, or nearly so. The flowers are therefore in the most favorable position for the visits of the less specialized insects, and the nectar and pollen are easily reached, the pollen in fact being completely exposed. The flowers are proterogynous, newly opened ones having receptive stigmas and closed anthers.

The indications point to an adaptation to the less specialized bees—*Andrenidæ*—which predominate during the blooming time and are the principal guests. The blooming time is from April 25th to May 12th. The following list was observed on April 30th:

BEES—*Apidæ:* (1) Ceratina tejonensis Cr. ♂, s.; (2) Nomada cressonii Rob. ♂, s.; *Andrenidæ:* (3) Andrena vicina Sm. ♀, s.; (4) A. cressonii Rob. ♀, s. & c. p.; (5) Halictus 4-maculatus Rob. ♀, s. & c. p.

freq.; (6) H. lerouxii Lep. ♀, s. & c. p.; (7) H. obscurus Rob. ♀, s. & c. p.; (8) H. stultus Cr. ♀, s. & c. p.; (9) H. sp. ♀, s. & c. p.; (10) Augochlora viridula Sm. ♀, s.; (11) A. labrosa Say ♀, s. & c. p.; (12) H. pura Say ♀, s. & c. p., freq.; (13) A. similis Rob. ♀, s. & c. p.; (14) Sphecodes smilacinæ Rob. ♀. s.

FLIES—*Empidæ:* (15) Empis humilis Coq. (MS.) s., freq.; *Bombylidæ:* (16) Bombylius major L., s.

SMILACINA RACEMOSA Desf. *Vagnera racemosa* (L.) Morong.—The stem is simple and inclined to one side so as to throw the terminal panicle into an horizontal position. The flower consists of six divergent stamens and the pistil. The segments of the perianth are very small and never enclose the stamens, the anthers being evident from the early bud. With the exception of the anthers all of the parts of the flower are white. By an increase in the number of flowers the panicle of this species is rendered even more conspicuous than the raceme of the preceding. The plant is more common, but is not often found in patches like *S. stellata.* The flowers are proterogynous with long lived stigmas. Cross-pollination is further facilitated by the stamens being strongly divergent. Spontaneous self-pollination can hardly occur.

There seems to be no nectar,[2] and the few visitors noted only sought for pollen. The blooming season is from May 7th to 30th. On the 17th, 18th and 23rd the following visitors were observed:

Andrenidæ (1) Halictus pectoralis Sm. ♀, c. p.; (2) H. 4-maculatus Rob. ♀, c. p.; (3) H. stultus Cr. ♀, c. p.

Scarabaeidæ: (4) Trichius affinis Gory, f. p.

UVULARIA L.—Nectar is secreted by the sepals (Engler 2). In the case of *U. perfoliata,* Alice Carter (4) notes the abundant visits of bumble bees. At Madison, Wisconsin, Trelease (MS. notes) saw it visited by *Osmia albiventris* ♂. He regards the flower as probably spontaneously self-pollinating. On account of the shorter stamens, this may not be so likely as in the following.

UVULARIA GRANDIFLORA Smith.—Kerner (3) mentions this species as an example of simple autogamy.

The stems grow 2 or 3^{dm} high and bear one or two greenish yellow, pendulous flowers. The divisions of the perianth are closely approximated and twisted, which makes it difficult for all except the largest and strongest bees to enter. Nectar is secreted and lodged in a pit at the base of each segment.

[2]This species has septal glands, according to Grassmann, Die Septaldrüsen. Flora 67: 118. 1884.

Access to it is impeded by the segment lying close to the opposite filament. The long anthers surpass the style. The outer three begin to discharge their pollen before the others, and the dehiscence begins at the base of the anther and proceeds upwards. The flowers are homogamous. The three divisions of the style are widely divergent, so that the stigmas are protruded between the anthers. They thus come in the way of a bee crawling in between the anthers and sepals. A bee laden with pollen will invariably effect cross-pollination, if it visit the flower early, and it may accomplish the same result later. But after the line of dehiscence has reached the stigmas, there is a chance of spontaneous self-pollination. Cross-pollination commonly results in cross-fertilization between distinct plants.

The observations of Trelease, at Madison, give results essentially agreeing with the above account. He saw the flowers visited by bumble bees.

In my neighborhood, the blooming season is from April 12th to May 6th. April 20th, 23d, 25th, 26th and 29th, the following bees were observed on the flowers:

Apidæ: (1) Bombus separatus Cr. ♀, s.; (2) B. ridingsii Cr. ♀, s.; (3) B. americanorum F. ♀, s.; *Andrenidæ:* (4) Andrena vicina Sm. ♀, s. & c. p.; (5) A. pruni Rob. ♂, s.

The flowers are evidently adapted to Bombus females, the only sex flying during the blooming season. The pollen collecting visit of *Halictus cylindricus* ♀ in the Berlin Garden (1) has no significance.

On the literature of *Uvularia* see:

(1) Loew, Beobachtungen über Blumenbesuch von Insekten an Freilandpflanzen. Jahrb. bot. Gartens Berlin. **3**: 278(76). 1884. *U. grandiflora* (flava)—(2) Engler, Liliaceæ. Engler u. Prantl, Die nat. Pflanzenfamilien. 2: 15. 1887.—(3) Kerner, Pflanzenleben **2**: 173, 330. 1891. —(4) Carter, Notes on pollination. Bot. Gaz. **17**: 21. Ja. 1892. (Just **20**[1]: 475).

TRILLIUM L.—From observations made in the Berlin Garden Loew (2) records that in *T. grandiflorum* Salisb. the flowers are proterandrous. They are white and expand about 9.5cm. The stamens are longer than the pistil by about 5mm. Loew was doubtful about the occurrence of nectar, but in the Botanical Garden at South Hadley, Mass., Miss Carter (3) noted its presence and says that it is secreted by septal glands. At first the mouth of the flower is closed by the anthers. Later the petals expand further, the stamens separate above, and the stigmas appear between them. She saw hive bees collecting the pollen. In view of Loew's observations and the statement of the Manual that the stamens exceed the stigmas, it is not easy to understand how the recurving stigmas will meet the anthers.

The white nodding flowers of *T. cernuum* L., according to Miss Carter, are slightly proterandrous, with a chance of spontaneous self-pollination by the stigmas recurving to meet the shorter stamens. She saw a bumble bee visiting the flowers for nectar.

T. erectum L., according to Loew, is a dark purple pollen-flower with offensive odor. The flower with its expanded or recurved petals measures about 7.5^{cm} across. In cases observed by him the anthers did not reach the height of the stigmas, but he mentions that the latter bend backwards. Miss Carter found the stigmas and anthers at nearly the same level. She regards spontaneous self-pollination as the rule. The Manual says that the stamens equal or exceed the stigmas. According to Weed (4) this species is proterandrous and adapted to cross-pollination. In New Hampshire he saw the flowers visited for pollen by two or three species of flesh-flies, among them *Lucilia cornicina* F. Miss Carter saw the flowers visited by four beetles, "certainly of little avail in cross-pollination and probably too late." The absence of nectar makes strong dichogamy improbable. The odor, color and the observed visits of flesh-flies suggest an adaptation to these insects, but the absence of nectar is hard to understand. The pinkish and white forms may be more attractive to insects, if they want the disagreeable odor and secrete nectar, but the greenish form is probably the most degraded. In fact this range of variation itself may be a sign of degradation. The flower seems to be losing its hold on insects and to form a transition between the other entomophilous species of *Trillium* and the still more degraded *T. sessile* and *recurvatum*.

TRILLIUM SESSILE L.—Loew (1, 2) classes this flower with *T. erectum*, but I have noted no disagreeable odor about it. We saw a beetle, *Cetonia aurata* L., gnawing the anthers. Miss Carter says that self-pollination seems inevitable.

In Patterson's Catalogue of Illinois Plants it is credited to Kankakee and Wabash counties. I have found it in only one locality. The sepals are not reflexed as in the next. The petals are greenish except at base, where they are dark purple, like the stamens and stigmas. This color is the only entomophilous character the plant shows. The stigmas are very large and have their edges thrown into convolutions. This great development seems to insure contact with the large anthers which surround them. On one occasion I found a number of beetles, *Centrinites strigicollis* Casey (Curculionidæ), among the anthers, feeding upon the pollen, and pairing. They seemed more likely to secure self-pollination, though in their slow movements to other plants cross-pollination might be effected. The flowers bloom from April 24th to May 15th.

TRILLIUM RECURVATUM Beck.—This is a common plant, blooming from April 8th to May 16th. The stems grow a few dm. high and bear single flowers, which are sessile upon the circle of three leaves. The sepals are green and reflexed. The petals are erect, arch over the stamens and are narrowed at base and tip. They are dark purple. The filaments and stigmas are of the same color, but the anthers are nearly black. The anthers are long and rigid, having a very broad connective which is produced above into a blunt point. They form a rather rigid cone over the pistil, so that the pollen can hardly be eaten or collected by insects. I find no nectar nor odor, in fact nothing to induce insect visits, except the purple color. It is possible that small flies resort to these flowers at night. The stigmas become elongated and recurved, so that with their convoluted edges they are quite likely to receive pollen from the anthers.

On the pollination of *Trillium* see:

(1) Loew, Weitere Beobachtungen über Blumenbesuch von Insekten an Freilandpflanzen. Jahrb. Bot. Gartens Berlin **4**: 149. 1886.—(2) Loew, Blüthenbiologische Beiträge. II. Pringsheim's Jahrbücher **23**: 78–9. 1892. (Just **19**¹: 417)—(3) Carter, Notes on pollination. Bot. Gaz. **17**: 20–1. 1892. (Just **20**¹: 475)—(4) Weed, Ten New England blossoms and their insect visitors 53–60. 1895.

MELANTHIUM VIRGINICUM L.—This plant is rare. It grows on prairies, sometimes in large patches. The stem rises from 1 to 1½ᵐ high and is terminated by a large pyramidal panicle of white flowers. The old flowers, which turn greenish yellow, are persistent, so that they render the inflorescence more conspicuous.

The flowers are andro-monoecious, most of them being perfect, but the uppermost ones in the panicle are staminate. They expand horizontally from 15 to 30ᵐᵐ. The sepals are nearly heart-shaped with long claws. At the base of the blade of each sepal there is a shallow depression containing two yellow nectar glands. The nectar is thus completely exposed. The claw of each sepal bears a stamen with an extrorse anther held in such a position as to touch a large insect which sips the nectar. The three outer anthers dehisce first. The perfect flowers are proterandrous, the stigmas not becoming receptive until the anthers have fallen. The three styles are strongly divergent, so that the stigmas may touch the insects visiting the sepals for nectar.

The flowers show a very peculiar assemblage of visitors, mostly flies and beetles. The latter seem to be the ones for which the adaptations are intended. Of these *Trichius piger* is the most abundant visitor that I have observed, and it can readily affect pollination. The flowers are of rather large size, and, owing to their completely exposed nectar, admit insects which can obtain nectar but can hardly touch anthers or stigmas.

Melanthium Virginicum blooms from the 16th of June to the 11th of July. The list of visitors was observed on July 3d and 5th.

DIPTERA—*Syrphidæ:* (1) Mesograpta marginata Say; (2) Syritta pipiens L.; *Tachinidæ:* (3) Trichopoda pennipes F.; (4) Cistogaster occidua Wlk.; (5) C. immaculata Mcq.; (6) Jurinia smaragdina Mcq.; (7) Micropalpus fulgens Mg.; (8) Phorocera edwardsii Will.; (9) Atrophopoda singularis Twns.; *Sarcophagidæ:* (10) Sarcophaga cimbicis Twns.; *Muscidæ:* (11) Lucilia sp.; (12) L. cornicina F.; (13) Musca domestica L.; *Anthomyidæ:* (14) Anthomyia sp.; (15) A. albicincta Fll.—all s.

COLEOPTERA—*Lampyridæ:* (16) Photinus pyralis L.; *Scarabaeidæ:* (17) Trichius piger F. freq.; *Chrysomelidæ:* (18) Diabrotica atripennis Say; *Mordellidæ:* (19) Mordella melaena Germ.; (20) M. marginata Melsh.; *Curculionidæ:* (21) Centrinites strigicollis Casey—all s.

HYMENOPTERA—*Andrenidæ:* (22) Halictus confusus Sm. ♀; *Sphecidæ:* (23) Sphex ichneumonea L.; *Chalcididæ:* (24) Perilampus triangularis Say—all s.

Carlinville, Illinois.

Aster tardiflorus and its forms.

MERRITT LYNDON FERNALD.

Probably no New England Aster has caused more confusion and has been less understood than *Aster tardiflorus* L. The plant was described by Linnaeus in 1763 from garden specimens introduced from northeastern America. These plants were low and weak, and grew in the Upsala garden for eighteen years before flowering, and then blossomed late in the season. Linnaeus described it as a smooth plant two feet high, with few axillary divaricate branches: the larger leaves spatulate-lanceolate, semi-amplexicaul, and serrate in the middle; the others decurrent at the base: flowers as in *A. Novi-Belgii;* the inner scales of the imbricated involucre longer than the outer.

In 1783 Lamarck described *A. patulus*, a plant brought to the Paris garden from northeastern America. Lamarck's plant was low and weak, two or three feet high, somewhat branching: the leaves smooth, ovate-lanceolate, sharply serrate, and a little narrowed at the base. From that time on a number of species were described from garden plants and subsequently referred either to *A. tardiflorus* or to *A. patulus.*

In the Flora of North America, Torrey and Gray placed both *A. tardiflorus* and *A. patulus* in the group of species described from garden specimens which had not been identified with native plants. Instead of using the Linnaean description of *A. tardiflorus*, however, they followed Nees von Esenbeck, whose plant is a form of *A. Novi-Belgii* L., adding in a note that, according to Lindley, the Linnaean plant is *A. patulus* Lam. *Aster patulus*, though then unknown in the wild state, seems to have been better understood by Torrey and Gray. They followed the description of Lamarck and added the note that "the cultivated plant has much the habit of *A. cordifolius*, etc., except that none of the leaves are cordate." Other characters are given which show that they had a definite conception of the species.

In his "Studies of Aster and Solidago in the older herbaria,"[1] Dr. Gray says in discussing the Linnaean types: "*A.*

[1] Proc. Amer. Acad. **17:** 167.

tardiflorus, founded entirely on specimens cultivated in the Upsal garden, is confidently identified with a low form of *A. patulus* Lam." And in the Gray herbarium there are European garden specimens which Dr. Gray has matched with the Linnaean sheets of *A. tardiflorus*, and which, at the same time, are not distinguishable from authentic specimens of *A. patulus* from the Paris garden. But in the Synoptical Flora of North America there is an attempt to distinguish the two species on the two characters in which the original descriptions did not coincide. Namely, *A. tardiflorus* is described as having leaves auriculate at base and essentially equal involucral bracts, with some of the outer foliaceous, while the leaves of *A. patulus* are described as attenuated at the base, and the involucral bracts more or less unequal. Various specimens, however, show that these characters are not permanent; there are well authenticated plants of *A. patulus* with leaves slightly auriculate and with involucral bracts subequal as in *A. tardiflorus* and *vice versa*. In fact it seems that by attempting to keep these species apart we are only making confusion.

The obscurity surrounding the Linnaean plant, as recently understood, and its ascribed characters of auriculate leaves and of outer foliaceous bracts have allowed many specimens of *A. Novi-Belgii*, and a few plants of *A. puniceus* to be placed with *A. tardiflorus*. *Aster tardiflorus* as a rule is a species very distinct from both *A. Novi-Belgii* and *A. puniceus*, though there are some forms which show a close relationship to those species. In general habit, however, the typical plant suggests *A. prenanthoides*, or species of the sub-genus HETEROPHYLLI (particularly *A. Lindleyanus*) and it apparently intergrades with them.

It is with the hope to throw some clearing light upon the confusion which has prevailed that I have given this outline of the history of these plants and append the following descriptions.

ASTER TARDIFLORUS L.—A rather slender plant from a span to three feet high, bearing few heads in a terminal cyme or many in a leafy open inflorescence: stems glabrous, or slightly hirsute above, or even white-villous in some more northern specimens: leaves thinnish, those of the radical shoots oblong or spatulate, crenate, on winged petioles; cauline leaves lanceolate to ovate-lanceolate, acuminate, tapering gradually to a sessile or slightly auriculate base; the leaves often gradually contracted to a winged petiole; leaves above glabrous or somewhat scabrous, beneath from glabrous to villous-pubescent, especially on the midrib; margin nearly or quite entire toward the apex and the base, but in the middle portion bearing regular coarse and sharp serrations, or rarely without serrations, particularly on the upper leaves: heads three to five lines high: bracts of the involucre sub-equal or indefinitely two- or three- seriate, linear to linear-subulate, acute or short acuminate, mostly ciliate, green toward the tip and down the midrib; the outer sometimes entirely foliaceous: rays pale violet, flesh colored, or almost white.—Spec. **2:** 1231. [Ed. 2], not of Willd. Spec. **3:** 2049. *A. patulus* Lam. Dict. **1:** 308. *A. Tradescanti* Hoffm. Phyt. Blatt. 86, *pl. D. fig.* 2, not of L. Spec. **2:** 876. *A. pallens* Willd. Enum. Suppl. 58. *A. praecox* Willd. l. c. *A. abbreviatus* Nees, Syn. Ast. 16. *A. Cornuti* Wendl. ex Nees, Gen. et Sp. Ast. 58. *A. acuminatus* Nees, l. c. 60. *A. vimineus* Nees, l. c. 68 in part.—In low woods, generally along streams, New Brunswick and New England, flowering from late August through October.

Specimens have been examined from the following stations:

New Brunswick: Keswick (John Brittain); Campbellton (R. Chalmers).

Maine: St. John River (Kate Furbish); Dover (M. L. Fernald); Mt. Desert Island (E. L. Rand, E. Faxon); Farmington (C. H. Knowlton); Woodstock (J. C. Parlin).

New Hampshire: Shelburne (E. Faxon); Bethlehem (E. Faxon, G. G. Kennedy). Lisbon (E. Faxon); Franconia (E. and C. E. Faxon, G. G. Kennedy).

Vermont: Smugglers Notch, very small plants with from one to three heads (C. E. Faxon); Sutton, near Willoughby Lake (E. Faxon); Newfane (A. J. Grout).

Massachusetts: Blue Hills, Quincy (G. G. Kennedy); New Bedford (A. W. Hervey).

Connecticut: Bolton (C. Wright), a somewhat doubtful plant.

ASTER TARDIFLORUS L., var. **lancifolius,** n. var.—Rather taller than the species, glabrous or slightly pubescent above: the leaves glabrous or sparingly ciliate on the margin, elongated-lanceolate, 3 to 6^{in} in length, 6 to 10 times as long as broad, tapering above to an entire long-acuminate tip and below to a slightly amplexicaul base; the teeth in the middle portion very stout and generally hooked, more scattered than in the type (sometimes half an inch apart): branches of the inflorescence few-flowered and short, rarely more than two-thirds as long as the leaves.—Growing in lower ground and generally a coarser appearing plant than the type, but passing into it.—In wet meadows and on shores with much the same range as the species.

Maine: St. Francis (M. L. Fernald); Mt. Desert Island (M. L. Fernald, E. L. Rand); Woodstock (J. C. Parlin); Farmington (C. H. Knowlton); South Poland (Kate Furbish).

Massachusetts: Ashland (Thos. Morong); Boylston Station, Boston (E. and C. E. Faxon); West Roxbury (C. E. Faxon); Jamaica Plain (E. Faxon).

Aster puniceus × tardiflorus, var. **lancifolius,** n. hyb.—A rather stout plant $1\frac{1}{2}$ to 2^{ft} high, simple or sparingly branched above: the purple or purple-tinged stem hispid with coarse spreading white hairs: leaves thick and leathery in texture, coarsely serrate in the middle; root-leaves elongated-spatulate, glabrous; cauline oblong-lanceolate, 3 to 6^{in} long, $\frac{1}{2}$ to 2^{in} wide, broadest above the middle; from the broadest portion tapering abruptly to an acuminate tip, and gradually to an auriculate base; above strongly scabrous, beneath glabrous or sparingly scabrous, and somewhat hispid on the broad white midrib: inflorescences leafy or naked, simply, or two–five-flowered and corymbose, in the axils of the upper leaves, only an inch or two high (barely half as long as the leaves): heads 4 to 6^{in} high, an inch or so broad; bracts of the involucre narrowly linear, three to four lines long, erect, loosely imbricated, mostly in one series, but with a shorter secondary outer series: rays pale violet.—Collected with *A. tardiflorus*, var. *lancifolius* in a meadow at Ashland, Mass., Oct. 24, 1878, by the late Thomas Morong; in marshes along the Mystic river, at Medford, Mass., Oct., 1893 and '94, by B. L. Robinson and M. L. Fernald; and at Beaver brook, Waverly, Mass., Oct., 1894, by G. L. Chandler. A plant combining the characteristics of *A. puniceus* and *A. tardiflorus*, var. *lancifolius*. The purple hispid stem suggestive of *A. puniceus*, is generally more slender than in that species, though stouter than in *A. tardiflorus*. The leaves are broader than in *A. tardiflorus*, var. *lancifolius*, but the coarse serration of the middle portion, and the cuneate lower portion are like that species; the auricled base, scabrous upper surface, and hispid midrib, however, are like *A. puniceus.* The inflorescence is decidedly like *A. tardiflorus*, var. *lancifolius:* the corymbs are much shorter than the leaves, but in well developed *A. puniceus* the leaves are shorter than the inflorescence. The scales of the involucre, too, are almost identical with those of *A. tardiflorus*, while in *A. puniceus* they are much longer, more lax and more distinctly uni-seriate. The rays are light violet like those of *A. tardiflorus*, not deep violet as in ordinary *A. puniceus.* The achenes in the intermediate form are all immature and show no striking characters. In working over the Asters for the Synoptical Flora of North America, Dr. Gray referred the Ashland plant to *A. puniceus;* but the sheet bears a note in his handwriting, apparently added sometime later, which suggests that the plant may be a hybrid with *A. patulus.* As this peculiar intermediate form seems to be restricted to a small portion of Middlesex county, I have ventured to follow this suggestion of Dr. Gray in placing the plant as above.

Gray Herbarium, Cambridge, Mass.

The root-tubers of Isopyrum occidentale.

D. T. MAC DOUGAL.

Soon after my recent paper dealing with the physiology of the tubers of Isopyrum biternatum[1] had passed into the hands of the printer, I received a number of living plants of *I. occidentale* H. & A. from California, and the root-tubers were found to exhibit such marked characteristics that a special consideration of its anatomy was deemed advisable.

Since this species is confined to a limited area on the Pacific coast and is but little known in a living condition I append the following description.[2]

"Roots fascicled, fibrous: stem 6–10^{in} high, parted above into few one-flowered branches; leaflets 4–8 lines long, irregularly 3-lobed: pods short, sessile, obliquely pointed.—Under oaks, or other trees and shrubs, among the foothills on either side of the valley of the Sacramento."

The tubers are formed by the enlargement of the portions of the roots nearest the root-stock, .5 to 3^{cm} in length, resulting in the formation of a dense hemispherical cluster of spindle-shaped structures with a diameter of 1 to 4^{mm}. Pale gray and shining when young, they become brownish with age, due to the formation of oil-drops in the outer cortical layers. Although not verified by actual observation the tubers appear to live and increase in size for several years.

The structure of the root, which differs in many important features from that of *I. biternatum*, may be best understood by following its developmental history, which is in the earlier stages similar to that of *Ranunculus repens*.[3] The stele is generally tetrarchic and in normal roots the xylem bundles undergo a centripetal development resulting in the total obliteration of the medulla. The endodermis is soon clearly differentiated while the cortex is quite similar to that of *I. biternatum*, already described. In the thickening of such roots into tubers the medullary rays are developed internally

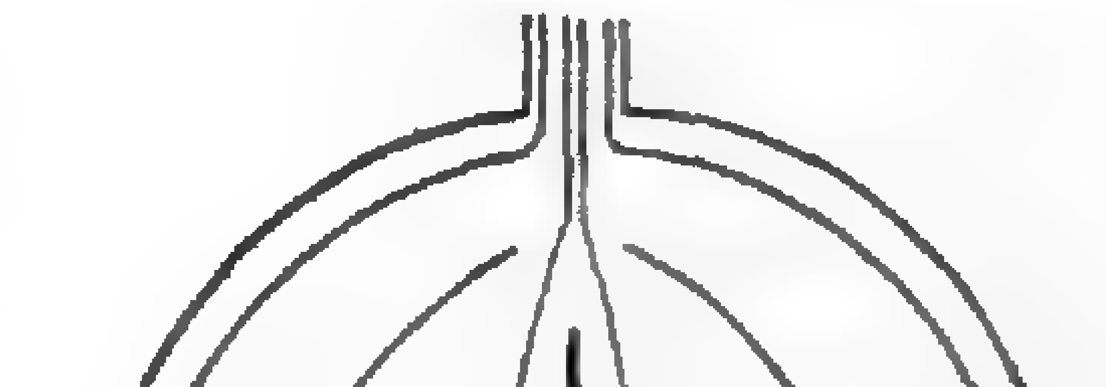
[1] A contribution to the physiology of the root-tubers of Isopyrum biternatum Torr. and Gray. Separate, March 31, 1896. Minn. Bot. Stud. 1: 500–516. *pl. 28 and 29.* 1896.

[2] Greene, Flora Franciscana, part III. 308. 1892.

[3] Vines, Text Book of Botany 165. *fig. 127.* 1895.

in such manner that the xylem bundles are separated and a comparatively large central mass of parenchyma is formed. A cylindrical mass of the cells in the central portion of this tissue, extending the length of the tuber only, undergoes sclerosis to such an extent that the cell-lumina are almost obliterated, and the walls are simply pitted. These sclerotic cells are cylindrical in outline, are joined transversely at the ends, and their length is several times their diameter.

A small bundle of secondary xylem is formed from each of the meristematic arches lying between the primary bundles. The larger part of the bulk of the tuber is due to the greatly accelerated development of the pericycle, resulting in the formation of a thick concentric ring of parenchymatous tissue, retaining in greater part its meristematic character, and differs from the corresponding region in *I. biternatum* in that it is furnished with numbers of small intercellular spaces. Extending to an indefinite distance from each primary bundle is a wedge shaped cambium ray. Near the cortex in the same plane as the rays are small bundles of elongated cells, which finally become woody, which have originated independently in the exaggerated pericycle. The cortex and endodermis show but little secondary change. In the latter an occasional newly formed radial wall may be seen.



Space is not at command for the proper citation of the numerous important papers bearing on the morphology of theroots of this group of the Ranunculaceæ, except to mention the work of Olivier[4] and Marie.[5]

In the comparison of the tubers of *I. biternatum* and *I. occidentale*, it can be seen that the formation of the tubers in both instances is due to the exaggerated development of the pericycle, and that the process in the first is accompanied by

[4] Recherches sur l'appareil tegumentaire des racines. Ann. d. Sc. Nat. VI. 2: —, —.

[5] Recherches sur la structure des Ranonculacees. Ann. d. Sci. Nat. VI. 20: —, —.

marked secondary changes in the endodermis and cortex, which do not occur in the root of either; in the second the development of the tuber is accompanied by the formation of secondary xylem bundles, and of a large medulla, the central portion of which undergoes a marked sclerosis: features entirely absent from the root. Further, the cambiform rays of *I. biternatum* are formed opposite the two secondary bundles and extend half the distance to the cortex terminating in a strand of woody cells originating in the pericycle, while in *I. occidentale* the cambiform rays are developed opposite the four or five primary bundles only, and extend only part way to the woody strands in the pericycle.

So far as the physiological features of the tubers of the last named species have come under observation, they show a close similarity to those of the first. The parenchymatous cells from the tubers of plants beginning to bloom March 24th gave the globular aggregations on the application of strong alcohol. A few weeks later they contained numbers of granules reacting as "red starch." The cortical cells were also filled with reddish brown drops of oil, and the outer layer was infested with a number of hyphae. The presence of sclerenchyma in the medulla and in consequence in the tuber alone is somewhat remarkable, and seems entirely unexplainable by any of the accepted principles of mechanical induction; a fact more clearly apparent when it is remembered that the tubers are clustered in a compact mass in such position as to be incapable of receiving strains of any moment. Neither may inferences of value be deduced from a consideration of the absence, presence, or varying disposition of the sclerenchymatous tissues in the roots of the closely related genera.

University of Minnesota.

Albert Nelson Prentiss.

GEO. F. ATKINSON.

WITH PORTRAIT: PLATE XIX.

Albert Nelson Prentiss was born May 22, 1836, at Cazenovia, Oneida county, N. Y. His father was a farmer, and his grandfather was an officer in the war of 1812, dying in the service.

His early education was gained in the public schools, and in the Oneida County Seminary of his native village. In 1858 he entered the Michigan State Agricultural College and was graduated in 1861 with the degree of B. S. His class, numbering seven members, was the first to graduate from that institution, and the entire class, responding to their country's call at the outbreak of the civil war, immediately enlisted in the service of the army. Albert N. Prentiss was enlisted in the engineering corps at Battle Creek, Mich., and assigned to special signal service duty in the army of the west. After four months service, principally in the field, in the interior of Missouri, his corps was disbanded in consequence of changes in the organization of the army which followed the removal of the commanding general.

In 1862 he was elected associate principal of the Kalamazoo, Mich., high school, which position he resigned during the following year to accept the instructorship of botany and horticulture in his alma mater, the Michigan Agricultural College at Lansing. He received the degree of M. S. from the same institution in 1864, and in 1865 he was promoted to the full professorship of botany and horticulture.

Aside from the duties appertaining to the educational features of the department he had charge of the grounds of the campus, and under his direction the face of the campus soon changed from the formal association of straight lines and angles to the place of beauty which it now is.

Among his pupils in botany at the Michigan Agricultural College are the following men whose lives have been devoted to the science and who have attained positions of eminence in their chosen fields: C. E. Bessey, professor of botany in the University of Nebraska; W. P. Wilson, professor of botany in the University of Pennsylvania; B. D. Halsted, professor of botany in Rutgers College, and botanist of the New Jersey Agricultural Experiment Station; S. M. Tracy of the Mississippi Agricultural College, director and botanist of the Mississippi Agricultural Experiment Station.

At the opening of Cornell University in 1868 he was called to the chair of botany, arboriculture and horticulture. The botanical department for several years did not have rooms devoted entirely to the work in botany, but made use of rooms at intervals when they were not occupied by other classes, and there was, therefore, a lack of room for carrying on desired laboratory work, as there was also at that time lack of suitable apparatus or illustrative material. The first course offered was in systematic botany during the autumn of the opening of the university in 1868. This was attended by four students who came from other institutions and who had some previous training in botany, the lectures being given in what is known as Morrill Hall. In the spring term the department was assigned two small rooms in a wooden building which had just been completed, more especially for the chemical and physical departments, neither of which rooms was large enough for the class of 144 students who attended the elementary course in the spring term. The lectures to this class were given in the chemical lecture room, where they were held for three years. For a number of years the members of this large class, through his influence, became interested in the local flora, and this led ultimately through the enthusiasm of such men as Dr. D. S. Jordan, now president of Leland Stanford, Jr., University, Dr. J. C. Branner and Professor W. R. Dudley, of the same institution, to a careful and systematic study of the interesting flora of this region, and the publication later by Professor Dudley of the *Cayuga Flora*. In 1875 the department was moved to more commodious and permanent quarters in the south wing of the Sage College, and the equipment in the way of models and other illustrative material had by this time considerably increased, and some other courses were offered. In 1873 an instructor, David S. Jordan, was for the first time appointed, and in the following year W. R. Dudley was appointed instructor, and continued to occupy this position until promoted to the assistant professorship in 1876–77. In 1881 the laboratory was further extended, and a large conservatory was erected in connection with the department.

For more than a decade in the early history of the university the entire oversight of the large grounds of Cornell University fell to the lot of the professor of botany, and to those who know anything of the wild condition of the grounds at that time the duties of this position will not seem small. In fact a large part of the time of Professor Prentiss during the early years was given to personal supervision of the improvement of the grounds and the planting of trees, many of the summer vacations as well as the spare time obtained from the instruction being devoted entirely to this work. One of the first plans projected by him for the improvement of the grounds was the starting of a small nursery of native plants, the seeds of which were planted at the opening of the university. Owing to lack of funds for the care of this nursery most of the young plants were lost, but a few were planted on the campus, and would thus, if protected, be of the same age as the university. Most of these trees in one way and another have disappeared, chiefly through the rapid expansion of the university beyond what was anticipated at the outset, so that they have largely been removed to give place to new buildings, to subsequent gradings of the grounds, etc. Of the number of these trees planted at that time it may be interesting to the friends of the university to know, that, so far as can be determined, only three pine trees remain, one situated on the Sage College grounds about 100 feet south of the botanical laboratory, while the other two are in the grounds of the residence of Professor J. H. Comstock, at the north end on East avenue.

In the summer and autumn of 1870 Professor Prentiss was absent in Brazil with what is usually spoken of as the "Cornell Exploring Expedition." In university history this expedition is usually known as the "Morgan Expedition" in honor of the Hon. Edwin Barber Morgan of Aurora, N. Y., who contributed a considerable sum toward the cost. The expedition was organized by Professor C. F. Hartt, at that time professor of geology, for the purpose of making collections in natural history and studying the natural resources of the country. A number of students accompanied Professors Hartt and Prentiss. The party sailed from New York the latter part of June, returning early in January, 1871. They explored the valley of the Amazon for a distance of about 400 miles above Pará, as well as the rivers Chingu and Tapajos, two of the principal tributaries of the Amazon. This gave Professor Prentiss an excellent opportunity to study the tropical flora and also to make some collections of material for the department. He also spent some time in Rio Janeiro and in other parts of Brazil.

In 1872 he spent six months in Europe devoting the largest share of his time to the Royal Botanic Gardens at Kew, London, and the Jardin des Plantes at Paris. Subsequent visits were made to Europe and a large number of the more important botanic gardens were visited and studied. In 1878 he was married to Miss Adaline Eldred, and having no children his wife has been able to accompany him in many of his travels.

During his connection with the department at Cornell many students have come under his direct influence, and doubtless a large number have received from his instruction an inspiration to become botanists or teachers of botany. Among the more prominent botanists who have at one time or another been students of his at Cornell may be mentioned the following: J. C. Arthur, professor of vegetable physiology at Purdue University; F. V. Coville, chief of the Division of Botany of the U. S. Department of Agriculture; W. R. Dudley, professor of botany in the Leland Stanford Jr., University; R. B. Hough, author of *American Woods;* J. A. Holmes, formerly professor of botany and geology in the University of North Carolina, now state geologist; W. A. Kellerman, professor of botany in the Ohio State University; W. R. Lazenby, formerly professor of botany, now professor of horticulture in the Ohio State University; C. W. Mathews, professor of horticulture and botany in the State College of Kentucky; V. A. Moore, bacteriologist of the Bureau of Animal Industry of the U. S. Department of Agriculture; C. F. Millspaugh, botanist to the Field Columbian Museum of Chicago; W. W. Rowlee, assistant professor of botany in Cornell University; W. Trelease, professor of botany in Washington University and director of the Missouri Botanical Garden; M. B. Thomas, professor of botany in Wabash College; R. Yatabe, professor of botany and curator of the botanic garden, University of Tokio.

Professor Prentiss' writings upon botanical subjects have been few. In 1871 he wrote an essay on the "Mode of the natural distribution of plants over the surface of the earth," which received the first Walker prize by the Boston Society of Natural History, and was published in pamphlet form (University Press, Ithaca, N. Y., 1872). Minor contributions have been made to some of the American botanical journals.

The most extended piece of botanical writing which Professor Prentiss accomplished has unfortunately not yet been published. This was a monograph of the hemlock, *Tsuga Canadensis*, for the Division of Forestry of the U. S. Department of Agriculture. The monograph was one of a series upon certain of our coniferous trees, prepared at the request of the chief of the Division of Forestry,[1] Mr. B. E. Fernow, by different authors. Professor V. M. Spalding made the monograph on the white pine, Dr. Chas. Mohr on the southern pines, Mr. Flint on *Pinus resinosa, rigida*, etc., and Professor Prentiss on the hemlock. According to certain financial requirements of the department at Washington, the time for the delivery of the monographs was extremely limited, so that when they were presented at the expiration of this limit, they were all necessarily short in observations of a kind which are needed to formulate rules for forestry practice, especially measurements at various stages of development not only of single trees but of groups in the forest. For this reason none of these monographs were printed at that time, and only now is the department in a position to publish Dr. Mohr's monograph, to be followed by the others in turn. These monographs included statistics of area and consumption, with a history of the economic development of timber supplies; brief botanical descriptions, including studies on wood structure, biology, the requirements of the species for its development, the progress through various stages of growth, etc., etc. Professor Prentiss' monograph was among the best, and very well put together, but was, like the rest, deficient in the respects mentioned.

The fact that his productiveness has not manifested itself in more frequent and pretentious contributions upon botanical topics may have seemed suprising to those who have not understood the conditions under which Professor Prentiss has labored. During the early history of the University the organization of a department when funds were not sufficient to at once build and equip suitable rooms for the large num-

[1] I am greatly indebted to the kindness of Mr. Fernow for these facts concerning the conifer monographs. G. F. A.

ber of students, the exacting duties as superintendent of the grounds for the larger part of his connection with the University, where constant personal supervision was necessary in connection with the improvement and care of 50 to 100 acres, was sufficient, with the duties as teacher, for a number of years without any assistance, to prevent the planning and carrying out of any extended investigations. During the later years, failing health, while it did not prevent him from attendance upon the duties of instruction and administration of his office, did not leave him sufficient reserve strength for the close and continued application necessary in conducting extended experiments or prolonged research. Punctilious to a fault in meeting his appointments, he rarely missed any of his classes, even when suffering from an indisposition which would have warranted an occasional respite. But during the last two years illness has at several times compelled him to give up all work for short periods, though he would return to work again when convalescent, and in such a state of health which would have constrained others to absent themselves longer from duty. But in the winter of 1896 he found it necessary in order that his health might be cared for to ask to be relieved from further active participation in the administration of the department.

At the winter meeting of the Board of Trustees he was elected professor emeritus in recognition of his long and faithful services to the University, and the faculty attested by appropriate resolutions the esteem in which he has always been held by his colleagues, and the value of his services and influence in the early history of the University, when it required men of strong faith and firm principles to stand up for the new and advanced ideals upon which Cornell University was founded.

Professor Prentiss is dignified and gentle. In his lectures he was a clear, precise, easy and fluent speaker, and in conversation a most delightful companion. To those who were not intimately acquainted with him he often seemed cold and unsympathetic, but those who knew him well, felt the charm of his manner and encouragement of his keen interest in the individual work of the student. As a pupil of Professor Prentiss the writer felt no restraint upon the most cordial relationship, and always experienced an exquisite delight in the personal discussions upon various topics connected with the lectures or investigations, and came to regard him more in the light of a dear friend than as a teacher. Later when he was associated with him as a colleague, the same deep interest in success and approval of research work characterized his relation to his former pupil. Cultivated and refined, his influence upon his pupils, upon his home, and in social life, has been alike gentle and elevating, and all his friends will sincerely wish that he may recover from the present trying illness, and be spared many years in the enjoyment of needed rest after a long period of active and exacting labors.

Ithaca, N. Y.

Noteworthy anatomical and physiological researches.

Carbon dioxide and living protoplasm.

The question as to the influence of CO_2 on the protoplasm has received much investigation but is not accurately determined. Giuseppe Lopriore, before giving an account of his reinvestigation of the question,[1] summarizes the previous knowledge as follows:

The influence of CO_2 upon the protoplasm of green plants is different from that upon the colorless protoplasm of the yeasts and bacteria. The latter are capable, in comparison with the green plants, of enduring a very large amount of CO_2, or even of living in almost pure CO_2. This relation, however, differs with different species of bacteria. Some thrive almost as well in pure CO_2 as in air; others show diminished growth; while a third group will only develop when the cultures are kept warm in the incubator. While CO_2 at ordinary pressure is not fatal to bacteria, at a higher pressure it may be.

The yeasts behave differently—even oppositely—according to the species. According to Brefeld yeast may grow in CO_2 which contains as little oxygen as $\frac{1}{6000}$ of its volume, which may therefore be considered almost pure. According to Foth, on the contrary, CO_2 exercises a strongly retarding influence upon the power of multiplication of yeast.

The relation of CO_2 to green plants is inferred from the experiments upon different vital phenomena which here may best be considered singly.

As to the germination of seeds, this does not occur in pure CO_2, which appears to kill embryos of swollen seeds. If the seeds are dry they resist its action as well as in air. In an atmosphere containing 50% CO_2 seeds cannot germinate, but viability is not lost for they do germinate upon being transferred to air. Seedlings which can stand this gas mixture when exposed to sunlight die, on the contrary, in an atmosphere containing only 8% CO_2 when they are kept in darkness.

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[1] Ueber die Einwirkung der Kohlensäure auf das Protoplasma der lebende Pflanzenzelle. Pringsh. Jahrb. f. wiss. Bot. **28**: 531–626. *pl. 2. figs. 3.* 1895.

As to the influence of CO_2 upon carbon-assimilation and the excretion of oxygen, most researches show that a small amount of CO_2 (4–10%) increases carbon-assimilation, while a higher percentage diminishes it, or even works injury to the plant. But carbon-assimilation depends on the function of chlorophyll, and this points to the fact that if the young plants are not provided with chlorophyll they could not bear this percentage of CO_2; for according to Boehm, the formation of chlorophyll is retarded in air with 2% and suppressed in air with 20% CO_2.

As to the influence upon the phenomena of movements, susceptibility to these does not entirely disappear even after a long stay (6–12 hours) in CO_2. So long as the plant remains alive irritability returns when the plants are transferred again to atmospheric air. In the sleep-movements of Oxalis leaves an accommodation to the CO_2-atmosphere is even possible. The plasma-streaming shows a like relation. Stopped by CO_2, it begins again after some time if the CO_2 is replaced by air. The motility of protoplasm is not destroyed unless the CO_2 acts too long.

Lopriore undertook to re-investigate the action of pure CO_2 and O in different proportions upon the vital activity of protoplasm without chlorophyll, and especially upon the growth of living plant cells. In the preparation of gases special precautions were taken to have them pure. The CO_2 was prepared by the costly process of heating potassic bicarbonate, which yields under the best conditions only half its gas—a process first used in physiological work by Schloesing and Laurent. The impossibility of obtaining CO_2 free from vapor of HCl when this acid is used to liberate the gas from marble determined the author to avoid this common process. The difficulty of refilling Kipp's apparatus on account of the gypsum formed when H_2SO_4 is used, although it yields extraordinarily pure CO_2, deterred him from using Bunsen's method. The potassic bicarbonate used must be chemically pure and specially tested as to its freedom from ammoniates and nitrates.

The oxygen was prepared by heating the purest potassic chlorate in a glass retort with the usual precautions. Hydrogen was at first prepared in a Kipp's apparatus from zinc and sulfuric acid and washed through plumbic acetate and KOH, but later compressed H was purchased and purified.

Five glass gasometers of 25[l] capacity each were used, after being carefully calibrated for each half liter. Three of these were used for pure gases and two for mixtures. It was found very difficult to secure a definite mixture, say of two parts CO_2 and one part O, and impossible to maintain it for any length of time on account of the unequal absorption by the water. This led to the employment of paraffin oil as a protection to the water. Eudiometric analysis showed that during twenty-four hours (the usual period for which a gasometer was used) no considerable alteration then occurred in the percentage composition of the mixtures. Gas analyses were made at frequent intervals to check errors.

The gas chambers in which objects were observed were of the form used by Kny, round shallow brass boxes 38×18^{mm} or 30×12^{mm} with entrance and exit tubes at the side, having the bottom of thick glass and the top a metal ring, with coverglass in the center, which screws on air-tight by means of an intervening washer. The object could then be placed in a hanging water drop on the under side of the coverglass.

After discussing the sources of error, the author presents a detailed account of his experiments, only the results of which can be here summarized from his own words.

1. Pure CO_2, if its action does not exceed a certain time, variable in different cases, has a retarding influence upon the vital phenomena, but not a permanently injurious one.

2. The retarding action of the CO_2 is not negative, due to the absence of oxygen, but a specific characteristic.

3. The CO_2 in many cases probably increases, either directly or indirectly, the extensibility of still growing membranes. In many other cases when the extensibility is not sufficient it brings about a rupture of the membrane of living cells.

4. A small amount of CO_2 (1–10 per cent.) accelerates the growth but does not raise the turgor-pressure of pollen-tubes which have been accelerated in growth. The turgor increases gradually if the pollen-tubes are, after a short exposure to CO_2, again exposed to atmospheric air.

5. Different cells of a plant are sensitive to CO_2 in different degrees.

6. Living plant cells may become inured to the disturbing action of CO_2. The plasma is also capable of a certain degree of accommodation.—R.

The phenomena of disorganization.[1]

The earlier researches regarding the death of the plant-cell have taken account chiefly of the dynamic sources of disorganization, such as heat, light, electricity, and given little attention to the material sources. Moreover they have largely overlooked the fact that the plant does not surrender its life without a fight, often of relatively long duration, which finds expression in the extraordinary internal alterations that are manifested whether the cell triumphs or surrenders, whether the disorganization is reparable or irreparable. The later researches have proceeded chiefly along two distinct lines, from the standpoint of the chemist and that of the physicist. The one views the cell-organism as essentially a chemism, the other as a mechanism. The researches of Loew and Bokorny are of the first sort, those of Berthold and of Bütschli of the second. Viewed thus the real characteristic of the organism, viz., the interdependence of the cycle of processes making up life (processes which we distinguish as chemical and physical), is put too far into the background. To the one the organism appears too much as a machine, to the other too much as a vessel in which chemical reactions are occurring. Rather we must consider the organism neither one nor the other, but that, as chemical and physical processes go hand in hand, we have before us a metabolic energy-transforming complex (Stoff-Kraftwechselsystem) comparable rather to a factory than to a machine.

Klemm determined to observe and compare the phenomena which became visible under the action of disorganizing media of known character applied designedly, and to see whether the likeness and difference in the death phenomena were merely superficial or were of deeper significance, depending upon the nature of the disorganizing agent. By choosing the proper amount or strength of the material or dynamic agent, and thus making the transition from life to death slow, Klemm endeavored so to arrange his experiments as to observe as many as possible of the phases of disorganization. It seemed specially important also to prove how the cells behaved under the gradual intensification of an agent up to an injurious degree as compared with the sudden application of the same agent of like intensity, so as to be able to distinguish clearly

[1] Klemm, Paul: Desorganizationserscheinungen der Zelle. Pringsh. Jahrb. f. wiss. Bot. **28**: 627–700. *pl. 2.* 1895.

the characteristic action of the agent from the reaction due to the sudden change of conditions. Great variability is to be expected not only according to the plant, but even among like cells of the same plant, and at different times and under different circumstances.

The symptoms of death are in most cases distinct enough, but in doubtful cases death was determined by the incapability of contraction on the addition of a plasmolyzing solution, or by the capacity to accumulate coloring matter, which appears only at death. Nigrosin, which is entirely harmless, was chiefly used for this test.

As dynamic agents Klemm used high and low temperatures, light, and electricity. As material reagents he used inorganic and organic acids, alkalies and alkaloids, H_2O_2, $CuSO_4$, $FeSO_4$, alcohol, phenol, and anilin colors.

As experimental material, that specially rich in protoplasm proved most serviceable, such as plasmodia of Myxomycetes, stamen-hairs of Tradescantia, cells of Spirogyra, filaments of Vaucheria and some marine Siphoneæ, hyphæ of Saprolegnia, and the root hairs of *Trianea Bogotensis*, which are finely adapted to the action of material agents because not cuticularized.

1. *Heat.* Previous observations mainly agree as to the visible alterations from high temperatures, viz., cessation of movement, rigor, and eventually aggregation or separation of masses of protoplasm. Klemm used Pfeffer's warm stage and determined, first, that gradual heating can be carried to a degree at which its sudden application is immediately fatal. Under these circumstances the alterations affect the movement rather than the form of the protoplasm. The first effect of heating beyond the optimum is to produce a condition of irritation marked by a feverishly rapid streaming. At a yet higher temperature the streaming was slowed with often tremulous movements of the plasma strands. This was succeeded by the formation of clumps here and there, and later by rigor. Hairs of Momordica and Tradescantia could be heated gradually to 51° without death. Contraction of the plasma from the wall followed, but when heat was applied suddenly no contraction took place. Killed in this way a strikingly granular appearance was imparted to the protoplasm. When heat is continuously increased turgor does not diminish until the death begins. By applying a heat of 42–45°C. at once

the internal revolution described by Sachs could be obtained; but it is readily shown that the plasma regains something of its original form if kept at this temperature, while if cooled the alteration of form becomes complete. The effects therefore are effects of change, not specifically of heat. Heat itself works disorganization without characteristic deformation, except the appearance of granulation in the last stage.

Low temperatures within the minimum showed essentially like effects. Only a sudden change produced any substantial deformations. Contractions of the plasma occur in considerable amount only at temperatures which after longer time produce death. These, therefore, are only the expression of the general injury, not the specific and immediate effects necessarily accompanying disorganization by abnormal temperature, which are purely internal and molecular and are expressed only by the granular appearance of the protoplasm killed by extreme temperature.

2. *Light.* No attempt was made to determine whether a lower limit exists, though the experiments of Hofmeister and Baranetzky mentioned in Pfeffer's *Physiologie* suggest such a possibility. Pringsheim established the fact that a high intensity of light can disorganize and kill protoplasm. But Klemm was not able to discover any phenomena which are typical of death through light, either because they occur exclusively or in higher degree under its action. Light, however, is not able to produce such intensive mass movements, when suddenly applied, as does heat suddenly applied.

3. *Electricity.* The disorganization produced by electricity, however, is of an entirely different character from that by heat and light, consisting of phenomena of solution which lead to the swelling of the protoplasmic layers and strands and to an extraordinary formation of vacuoles. The alterations mentioned in the older literature therefore are only the beginnings of the action which find outward expression especially in the streaming plasma—only the gross deformations which perhaps have their origin chiefly in the mechanical action of the induction shock, while the peculiarity of the electrical action lies in the internal changes it produces, leading to a frothy vacuolization of the plasma. This is made even more evident when the motion of the plasma is previously checked by withdrawal of oxygen or by chloroform.

4. *Reagents.* Acids produce, as characteristic disorgani-

zation phenomena, a granulation pointing to precipitates in the protoplasm, and a rigor, without any considerable contraction. It is this which has made them useful as fixing reagents in microtechnique. Alkalies and alkaloids disorganize by producing an abnormal solubility of the constituents of the protoplasm, so that it becomes vacuolated like a mass of foam, thus resembling in effect electric currents.

With hydrogen peroxide an extremely fine fibrillar structure of the plasma was produced, the fibrils mostly running lengthwise, a few traversely, and either ending free or joined into a network. Even the nucleus appeared not simply granular but like a coil of fibrils. The metallic salts produced no visible changes of structure or configuration. Anilin stains bring about an aggregation of the protoplasm as Pfeffer showed. Klemm sought to observe the fate of the cell after aggregation and to determine whether it is capable of life in spite of the experience which the mass of the cytoplasm has undergone, and whether, perhaps, the extruded balls are again taken up into the plasma. Though he used the large rhizoids of Chara he was not able to see that the cells had suffered any considerable injury, nor that the balls were again taken up into the plasma, though they were many times crowded deep into it. The balls themselves retained their life for a long time.

Summarizing his results Klemm says: In disorganization produced by forces and substances there is no single visible phenomenon common to all. The separate alterations to be observed are: *collapse* of the protoplasm, in which the diminution of turgor finds expression, *deformation* consisting of gross alteration of contour and separation of parts of the protoplasm, and finally *structural alterations* in the protoplasm.

1. That many agents at the very beginning of disorganization produce a diminution of turgor, either by changing the cell-sap or the resistance of the plasma to filtration, is certain. Yet this rarely goes so far as to produce real contraction, severing the protoplasm from the wall as in plasmolysis. After death turgor is, naturally, always diminished; yet irregular contraction, collapse, never appears; nor does it as a specific effect of any disorganizing medium. On the contrary collapse may or may not take place with any agent. Whether it will or not depends on the degree of harmfulness. The more harmful, whether on quantitative or qualitative

grounds, the less does the plasma collapse. Thus, no collapse occurs with a high intensity of light or heat, a high concentration of alcohol or acids, while on the contrary it does occur with low intensity or concentration. By no means all agents tend to diminish turgor; an increase even, of osmotic pressure is not excluded.

2. Alterations of configuration, such as formation of nodules, aggregation, separation of protoplasm, are a consequence of the sudden intensive action of many agents. They are wanting on the gradual application of agents to an amount or degree equal to that at which a sudden application produces such deformations. Alterations of internal movement to external recognizable mass movements go on only when agents are introduced suddenly.

3. Alterations of internal structure of protoplasm are not to be observed in all disorganization. When recognizable at all they fall into three categories: (1) Secretions of various forms, principally small grains which give to the plasma, in comparison with the normal, a much more granular appearance. They may be united into chains, nets, dendritic and other groups. These secretions may even take the form of fibers and impart a fibrillar appearance to the plasma. (2) Phenomena of solution which manifest themselves in the formation of vacuoles. In consequence of this vacuolation the plasma may be completely transformed into a foam. The vacuoles may be of considerable size but in part they lie near the limit of microscopic observation. This action is typical of basic substances and appears generally in consequence of electric shocks. (3) Coagulation of the plasma with granulation and formation of vacuoles, few and of small size. This occurs in many cases, especially in mechanical destruction of the protoplasm.

The alterations of the nucleus are in general completely analogous to those of the cytoplasm.

The structures of the protoplasm observed by different investigators, reticular, fibrillar, alveolar, are not permanent structures of high physiological significance but are only different states, producible at will in one and the same protoplasm.—C. R. B.

The physiology of tendrils.

Our knowledge concerning the irritability of tendrils has been considerably enlarged by Dr. Carl Correns.[1]

He finds that when the temperature surrounding tendrils is either suddenly raised or suddenly lowered between sufficiently separated extremes, a reaction, in all its phenomena like that released by a contact stimulus, is found to follow. The change, as such, affords the stimulus.

When the entire tendril is exposed to the same temperature conditions, it begins to roll in at the tip, continuing, if the temperature change be great enough, until several coils are formed. When the temperature is again brought to the normal, an unrolling of the tendril follows until it reaches again its original form. Or, if the new temperature limit is not so high as to produce a loss of sensitiveness, the tendril gradually accommodates itself to the new conditions when they are maintained, and uncoils. All the essential features of a typical reaction are to be observed.

The minimum temperature difference necessary to cause a perceptible reaction is, in case the experiments are conducted in the air, 10°C.; when tendrils are immersed in water, 7–8°C. If the change of temperature is gradually made, no reaction is seen to follow.

When the tendril is warmed locally, the reaction to the temperature change begins at the warmed place.

Tendrils are found to bend in a plane fixed for each tendril by its physiologically bilateral structure; hence whether warmed from any one side or placed so that all sides are warmed alike, the curvature always takes place in a particular predetermined plane. No tendrils observed were found to be physiologically radial.

The author decides that as far as he can discover, tendrils do not obey Weber's law concerning the relation of stimulus to reaction.

In regard to the method by which the organ carries out the various curvatures found, the author agrees with Pfeffer in referring it to variation of turgor pressure.

As was noted in the April GAZETTE, MacDougal, in 1892, observed that a temperature elevation to 40°C. causes a curvature of the whole tendril and local warming produces a local bending. He says, "the results from these high and low tem-

[1] Bot. Zeit. **54:** 1–20. 1896.

perature stimuli are doubtless due to their direct influence on the osmotic action of the cells."[2]

Correns finds that the most various kinds of solutions, so dilute as to cause no injury, call forth in tendrils a typical reaction. Since the cuticle is with difficulty penetrated, rather strong solutions are sometimes necessary to cause the reaction, e. g., iodine solution, 0.00192 %. Even stronger concentrations of other substances cause no injury and call forth the reaction, e. g., acetic acid, 2–6 %; arsenic, 1 %; chloroform, 10 %. Ammonia vapors also cause a plain reaction.

MacDougal found that when tendrils were submersed in solutions of the ordinary metallic salts (no concentrations given), "the induced osmotic action quickly caused curves." Unless penetrated and killed immediately, the tendrils were thrown into coils.[3]

In the case of the chemical stimulus Correns finds that accommodation takes place when the concentration of the solution is gradually increased.

A few experiments with induction currents renders it probable that they too are able to produce reactions similar to those described.

Correns studied the tendrils of Cucurbitaceæ and Passifloræ mainly, but other tendril-bearing forms were not neglected.—RODNEY H. TRUE.

The physiology of Drosera rotundifolia.

In his work on *Drosera rotundifolia*, Darwin[4] arrived at the conclusion that the speed with which the tentacles show curvature reactions varies according to the temperature, from 48.8°C. to 51.6°C. being especially favorable.

Dr. Carl Correns[5] regards this conclusion, that a temperature elevation releases irritation movements, to be worthy of further attention since phenomena of this kind are not of common occurrence. When leaves were cut from the plant and placed in distilled water which was brought to the desired temperature, his results agreed with those of Darwin obtained by the same method. When entire plants in the atmosphere were subjected to a rapid or a gradual elevation of the tem-

[2] BOT. GAZ. 18: 125. 1893. [3] BOT. GAZ. 17: 207. 1892.
[4] Darwin. Insectivorous Plants 66. 1875. [Ed. I.]
[5] Carl Correns, Bot. Zeit. 54: 21–26. 1896.

perature to the limit set by Darwin, no curvature of the tentacles was to be seen. The conduct toward temperature change varies, therefore, according to the nature of the surrounding medium, and causes aside from temperature are operative. He found, in fact, that distilled water at ordinary temperatures acted as a stimulus, and in a slight measure, the temperature elevation hastened and strengthened the reaction. From ecological considerations this conclusion is surprising. Distilled water prepared with the utmost care gave the same result, impurities being, therefore, in no way responsible.

To test Darwin's statement that leaves react more rapidly at higher temperatures, Correns used as irritants dilute solutions of sodium chloride (1:8400), sodium nitrate (1:840) and acetic acid (1:333) at two temperatures, 18 to 21° C. and 48 to 52° C. He found that the strength and speed of the reaction of Drosera leaves to chemical stimuli is increased by an elevation of temperature.

Water from the Tübingen water works undistilled, caused no reaction, leading to the conclusion that impurities were responsible, not for the reaction, but for the absence of reaction, to water. When this water was distilled, a reaction followed. By adding to pure distilled water pulverized calcium carbonate in the presence of carbonic acid, no reaction followed. Calcium phosphate and calcium nitrate behaved in a like manner. We have, therefore, in the calcium salts, substances which, like ether, make Drosera leaves insensitive to chemical stimuli. This fact was known to Darwin.

The author found that 0.1% calcium nitrate entirely prevents any reaction; 0.02% still exerts a noticeable influence; 0.01% is without apparent effect.

Drosera leaves seem to react in an especially pronounced manner to ammonium carbonate in dilute solution (0.05%). A comparison of effectiveness in their specific directions of calcium nitrate and of ammonium carbonate showed that from five to ten parts of the former are necessary to physiologically balance one part of the latter.

The growth habits of *Drosera rotundifolia* stand in accord with the above results since this plant with its companions, the sphagna, are found only in soils poor in lime. Cultures of Drosera watered with hard water quickly die.—RODNEY H. TRUE.

BRIEFER ARTICLES.

Notes upon Tradescantia micrantha.—*With Plate XX.*—I have been much interested in the rediscovery of this pretty little spiderwort. Although not uncommon in its native haunts it was not collected again for forty years after its discovery. Until recently it has not been represented in any of our larger herbaria except by the single type specimen in the Torrey herbarium at Columbia College.

The history of the plant is as follows: A single specimen was collected about 1854 near the mouth of the Rio Grande by A. Schott, who was then one of the collectors of the Mexican Boundary Survey. In 1859 it was described by Dr. John Torrey in the Report of the Mexican Boundary Survey. All the descriptions since then have been based on this short account. The plant was rediscovered by A. A. Heller at Corpus Christi, Texas, in the spring of 1894. He wrote me that the plant was very plentiful near the Oso, growing among and under thorny bushes. Only a very few specimens were obtained owing to the difficulty of getting at the plants. The material came into my hands August 28th, 1894. Since April 12th, a period of four and one-half months, the plants had been either in press or in a bundle of porous papers, and yet they still showed some signs of life. Two joints were planted in the green house where they soon took root and grew so rapidly that in a very short time we had some 400 plants. Some of this material has been distributed to the leading botanical gardens in the United States. In this connection I might state that the Division of Botany, Department of Agriculture, will gladly send cuttings to any one who would like to grow the plant. It is, perhaps, of little horticultural value, although we have not experimented very much with it. It might be used in hanging baskets with good effect in connection with other plants having dense foliage, but its elongated internodes and short stiff leaves will prevent its use alone. The plant naturally grows close to the ground, rooting at every joint and forming quite a thick carpet. It might be used to advantage in clumps or masses. The flowers are produced in great abundance and though small are very pretty and quite persistent for this order. Although the flowers last but a single day, they remain open until late in the afternoon, and with little care plants will flower for several months. In no case have any of our plants set seed.

This *Tradescantia* is very unlike any of the other United States species. In habit it most resembles *T. floridana,* from which it is easily distinguished by its flowers. It was originally described as having pale blue flowers, while in fact they are bright pink. The buds are sharply 3-angled and the anther cells are separated by a peculiar broad connective. I append a full description of the species.

Stems slender, rooting at the joints, flaccid, glabrous except a narrow line of pubescence extending down from the mouth of the sheath; joints sometimes elongated, 3.7^{cm} long: leaves thickish, ovate to lanceolate, acute, 12 to 30^{mm} long, keeled beneath and often somewhat reflexed, with slightly scabrous margins; sheath short, connate, with villous margin; spathe a pair of leaves (not connate as originally described) or occasionally of a single leaf: umbel always terminal and sessile, 6-flowered; bracts among the flowers 6^{mm} long, green or purplish, linear, acute, bearing on their margins short stiff hairs: pedicels 12 to 16^{mm} long: buds sharply triangular and acute: sepals 3, equal, greenish, 6^{mm} long, keeled on the back and pubescent along the midvein: petals 3, bright pink (not "pale blue"), a little longer than the sepals, obovate to orbicular: stamens 6; filaments all bearded below; anther cells separated by a broad obtuse connective: style as long as the stamens, slightly capitate.—J. N. ROSE, *Department of Agriculture, Washington, D. C.*

EXPLANATION OF PLATE XX.—*Trdescantia micrantha* Torr. Fig. 1, bud; 2, cross section of same; 3, flower; 4, stamen; all somewhat enlarged. Drawn by Miss Mary C. Gannett.

EDITORIAL.

The publication of "state floras," when well done, has many important uses. These floras have become so numerous that almost every state is represented. Those who are preparing general manuals or are monographing groups are much interested in learning the range of their plants, a thing which herbaria seldom completely record. The artificial boundaries of states, however, are not biological boundaries, and, while they serve to divide a large area into smaller ones much more convenient to explore, they rob the term "flora" of much of any biological significance it may have. This unfortunate condition of affairs is further encouraged by the fact that the state appropriates money for such purposes to be expended only within its borders. Thus the artificial boundary line and the state appropriation have resulted in "state floras." It is well, perhaps, for local botanists to discover and record the plants of their county or their state; but it is also well to remember that this is but preliminary to a proper study of the flora. A flora in nature does not recognize state boundaries, unless those boundaries happen to be coincident with biological barriers; therefore, the real study of a flora is something which does not concern itself in general with such boundaries. We have lists of the plants of Ohio, and Indiana, and Illinois, these lists being usually styled "floras;" but we have no definite biological areas, no real floras, mapped out in these states, whose plant lists largely repeat each other. That there are such distinctive floras is often indicated in the introductory remarks which preface the lists.

It is not our intention to decry the useful work of making lists, but to urge that the time has come for the presentation of real floras. If for any reason such work must be confined to a single state, even though that state merges biologically into others on every side, that single state can be treated biologically. The prairie flora of one state, instead of being intercalated among its forest and sand-dune floras can be distinctly set apart, and left in a condition to be fitted on to its continuation in the neighboring state. The sand-dune flora of northern Indiana should never be torn violently away from that of northern Illinois and lost sight of in the forests, and swamps, and prairies, and "knobs" of Indiana. Repetition of plant names and lack of repetition in presenting these real floras are both full of significance; certainly much more so than they are in lists of neighboring states. Such work is more difficult, naturally, and hence more valuable than the making of lists with no reference to floras. One is thoughtful classification, the other mere catalogue making. To define a biological area and then to observe not merely what plants grow upon it, but chiefly their distribution with reference to each other and to the area, is a difficult bit of field work, calling for training and good judgment, but it is correspondingly valuable.

Another danger in the compilation of a "state flora" is that the compiler is inclined to lay special stress upon those plants which may be new, or peculiar to the state, or rare. Such plants, it is true, are very interesting, and suggest certain things; but the enthusiasm they excite is out of all proportion to their scientific value, and is a survival of the "collector" spirit, which has in it no thought of biology. The facts of real biological significance to be observed in the study of any flora are to be obtained largely from the common and hence neglected plants. They are the species which endure diverse conditions, which vary widely, which develop divergent characters, which are full of information concerning natural selection, heredity, geographical distribution, etc. A list of plants so rare that their remains are to be found in but few herbaria may make the eyes of a collector glisten, but the biologist will take far more satisfaction in a few good observations upon the behavior of some common plant.

* * *

The Gazette has frequently urged American botanists to give heed to the literature of a subject before publishing upon it. Our admonition seems to be now needed in another quarter, perhaps more than in this country. For American botanists with any thorough training are aware that the activity in Europe has been so great and of such long standing that it would be foolish not to know whether a topic which presents itself for investigation has been studied before or not. We have some recent evidence, however, that our European friends are inclined to neglect the modern development of research in this country. There is excuse for this neglect, it is true; but an excuse presupposes a fault. European anatomists and physiologists may have had comparatively little reward in the past in examining American periodicals, but they must take heed that this day is passing. The men who have been stimulated to research by a German sojourn as well as those who have been inspired by their American teachers are rapidly making a literature which our German and French fellow workers cannot afford to overlook.

In fact a good many German botanists rather pride themselves upon their lack of attention to foreign publications, we suppose with the idea that whatever is worth knowing about a subject will either be discovered in Germany or published there. Consequently few botanical institutes are adequately supplied with foreign literature. This condition, which arises chiefly from a want cf appreciation of the work of foreigners, but partly from limited linguistic training, is a reproach to any people and our German friends would do well to better it. A few, notable among whom is Prof. Dr. Goebel, recognize fully the recent advance among American workers, a recognition which we doubt not will widen as the reasons for it become more potent. But without waiting for further development the institutes at Leipzig, Bonn, Tübingen, Breslau and Strassburg might better their own researches as well as facilitate those of their American students by stocking their libraries more completely.

CURRENT LITERATURE.

Botanical Directory.

MR. J. DŒRFLER has just issued the *Botaniker-Adressbuch* which we announced last July.[1] It contains 6,455 addresses of botanists, botanical gardens, institutes, societies and periodicals. A considerable number of these have been supplied by the addressees themselves and these are distinguished by an asterisk. On each continent the arrangement is by countries in alphabetic order. The names of botanists and of periodicals of that country are alphabetic in different lists while the gardens, societies and institutes, are arranged by cities. The special department of study is given in addition to the official position (if any) and postal address. Of course it is impossible to say anything as to the general accuracy of such a work. In the United States there are given approximately 1,700 names. We suppose these have been largely compiled from previous directories. Probably one-third of them have no title to place in such a directory, but there are always a considerable number of people so anxious to see their names in print that it is quite impossible to keep them out. However it is better to include too many than to omit those who ought to be included. Among omissions we note in a hasty examination Dr. D. H. Campbell and W. R. Shaw of Leland Stanford Jr. University, W. J. V. Osterhout of Brown University, O. F. Cook of Huntington, N. Y., W. L. Bray and E. B. Uline of Lake Forest University, Prof. W. C. Stevens of University of Kansas. Among our own contributors for 1895 we note the omission of the names of Misses Mary A. Nichols, Ida Clendenin, Bessie L. Putnam, Alice E. Keener, Margaret F. Boynton, Maria L. Owen and Mr. G. H. Shull, most if not all quite as well entitled to insertion as many which appear. Doubtless there are some others. Typographical errors are rather numerous though readily explicable on the "blindness" of poor chirography in proper names. Professor Tracy of Mississippi appears also as Pracy and Mr. Scribner both as Scribner and Lamson-Scribner. "Miss Effie Southworth" still appears in the list and, curiously enough, immediately above Prof. Spalding's name, which she now bears, while Dr. Kellerman is

[1] Dörfler, J.: Botaniker-Adressbuch. Sammlung von Namen und Adressen der lebenden Botaniker aller Länder, der botanischen Gärten, und der die Botanik pflegenden Institute, Gesellschaften, und periodischen Publicationen. Large 8vo, pp. xii + 282. Wien: 1896. Published by the author, Barichgasse 36, Wien III, Austria. $2.40 post free.

entitled "Mrs." Our Teutonic friends do not seem able to compass the English *I* and *J*, which is a fruitful source of error in this list. Nor has the editor appreciated the humor of the young woman who gives her official position as "housekeeper," which he faithfully records. Other errors are due to long survival of names in these directories. Pres. D. S. Jordan, of Stanford University, a zoologist, in 1873 an instructor in botany at Cornell University but scarcely interested for the last twenty years in botany, is listed, as is also Dr. P. S. Baker of De Pauw University, a chemist once giving some attention to plants.

But in spite of errors the directory is a very decided improvement in arrangement, typography, and completeness upon the last one compiled by Wilhelm Engelmann in 1891. And if botanists will take pains to send corrections and additions to the editor, Herr J. Dörfler, Barichgasse 36, Wien III, Austria, these shortcomings can be corrected in the next edition. Mr. Dörfler deserves commendation for the promptness with which he has compiled this list and his energy in publishing it at his own risk. He should be rewarded by a large sale of it.

Minor Notices.

Teachers of botany would do well to consult a lecture by Prof. J. M. Macfarlane, of the University of Pennsylvania, on the organization of botanical museums in high schools, colleges, and universities. This lecture was delivered at the 1894 summer session of the Marine Biological Laboratory at Woods Hole and has recently been issued as a separate from the Biological Lectures for that year published by Ginn & Co.

The botanical seminar of the University of Nebraska, whose activity in so many lines is to be commended, published some months ago, in a handsome pamphlet, the address of Dr. John M. Coulter before the seminar on May 27, 1895. Only 363 copies of the address, each numbered, were printed. Dr. Coulter's subject is "The Botanical Outlook" and his address must have been stimulating and suggestive to the energetic body of students to whom it was addressed.

Professor Penhallow has prepared a scheme of classification which has been issued in book form,[1] adapted to the use of students, having space for notes. Five branches are recognized as in Goebel's Outlines, etc., whose subdivisions are given as far as orders, except in angiosperms. An attempt is made to show the chief sexual characters and to keep homologies plain. But the scheme of typography is too intricate to explain by words, though simple enough to understand when seen.

[1] Penhallow, D. P.: Outlines of classification of plants. 12×9 inches. 16 pp. Montreal: E. M. Renouf. 1895.

The flora of Pasadena (Cal.) and vicinity[1] is a list of 1056 plants of all groups which have been collected about the city named, chiefly by the author, Prof. McClatchie of Throop Polytechnic Institute. The list is represented by specimens in the herbaria of the author and of the specialists to whom certain groups have been submitted. Sixty-two species are new to science and have been described in the various journals and proceedings cited. The author deserves commendation for his course regarding both these points.

The semi-annual report of Schimmel & Co. for April, 1896, on essential oils and similar products, both natural and synthetic, again contains much of interest to botanists. The discussion of the citrous oils of lower Italy and Sicily is especially full and is accompanied by a map showing the regions and centers for the production of citron, bergamot, and orange essences. Curiously enough the citron oil which comes from different regions in Sicily has different optical rotatory power, ranging from 59°–61° to 63°–67°. We note also the preparation by Messrs. Schimmel & Co. of synthetic cinnamic aldehyde, the aromatic principle of oil of cinnamon; a synthetic jasmine oil exactly reproducing the unique fragrance of the jessamine; and a synthetic ylang-ylang oil.

A separate from *Hedwigia* (**35**: 58–72. 1896) contains a supplement to Röll's former paper describing mosses collected by him in the northwestern United States. Unfortunately for American bryologists Mr. Kindberg, who has made so many "new species" has "looked through" Röll's collection and has made a number of new names. We cannot say new species, though they are so labelled. One is thus characterized: "*Philonotis acutiflora* (*sic*) Kindb. sp. n. Perigonialblätter spitz und gerippt." And this when the perigonial leaves of one of its nearest congeners are both pointed and costate! While Mr. Kindberg adds nineteen new names, some of them *nomina nuda*, MM. Renauld and Cardot have only been able to discover four new varieties. There is evidently a difference between being a bryologist and a species-maker.

The flora of West Virginia is one of the most important we have yet to deal with. Its widely varied conditions, its position between the northern and southern floras, its large unexplored territory, all combine to make it an attractive field to botanists. It is a pity that we are compelled so often, for various reasons, to limit our so-called

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[1] McClatchie, A. J.—Flora of Pasadena and vicinity. Reprinted from Dr. H. A. Reid's History of Pasadena. 8vo. pp. 605–649 figs. 19. The Author: Pasadena, Cal. 1895. 25 cents.

"floras" by arbitrary state boundary lines, but probably that of West Virginia is as nearly natural as any bounded by state lines. The second publication[1] in the botanical series now being issued by the Field Columbian Museum deals with this flora. A brief introduction outlines the botanical history of the state, the special features of the flora, and the forests. The list of species contains 2,584 numbers, 1,095 of which are thallophytes, among which there are 36 new fungi, 123 are bryophytes, 57 are pteridophytes, and 1,309 are spermatophytes. A host index and a list of local plant names conclude the paper. An interesting statement is that West Virginia has a greater amount of hardwood timber in its forests than any other state, and that probably two-thirds of the state is still covered by virgin forests.

ATTENTION should have been earlier directed to the thesis of Miss Grace E. Cooley, presented to the University of Zurich for the doctor's degree, entitled, "On the reserve cellulose of the seeds of Liliaceæ and of some related orders," and published in the *Memoirs* of the Boston Society of Natural History **5**: 1–29. *pl. 6.* Jy. 1895. Using the term "reserve cellulose" for the material deposited on the walls of the endosperm cells, and not defining it chemically as Reiss has done, Miss Cooley finds that it is present, to the exclusion of reserve starch, in the twenty-eight genera of Liliaceæ, Amaryllidaceæ, and Iridaceæ examined, with the exception of Paris and Trillium; that reserve cellulose is not identical microchemically with pure cellulose, probably consisting of a ground substance identical in all (with the possible exception of Paris and Trillium) with which is associated other substances in small amount giving rise to the slight differences observed in behavior with reagents. In germination it is transformed into oil (starch is only an end product) which is absorbed by the cotyledon. It is laid down as a secondary product upon the walls soon after the endosperm is formed, beginning in the part near the chalaza. The angles thicken first and the sides later. Sugar and oil are present in the cells before the reserve cellulose appears.

MR. W. W. CALKINS has published an account[2] of the lichens of Chicago and vicinity, this being the first of a series of papers concerning the flora of Chicago to be published by the Chicago Academy of Sciences. The author gives a brief account of lichens in general, under

[1] MILLSPAUGH, CHARLES FREDERICK, and NUTTALL, LAWRENCE WILLIAM.—Flora of West Virginia. Field Columbian Museum, Publication 9. Botanical Series, Vol. I, No. 2. Pp. 69–276, with plates and maps. Chicago: January, 1896.

[2] CALKINS, WILLIAM WIRT.—The lichen-flora of Chicago and vicinity. Bulletin No. 1 of the Geol. and Nat. Hist. Surv. of the Chicago Acad. Sci. April, 1896.

the heads: "what are lichens?" "the divisions of lichens;" "the thallus and apothecium—some of their organs;" "the development and progress of the science of lichenology;" "economic uses of lichens." Under the first heading the following quotations may be of interest:

"Lichens are a natural order of aerial plants which are considered as intermediate between Algæ and Fungi, but the limits are still uncertain. All are Thallophytes destitute of stem, leaf, root, or flower, and vegetate under the influence of moisture, obtaining the elements necessary to their growth from the air, and not from their substrates, as do the Fungi."

"In the thallus are green cells called gonidia, and other organs, as spermogonia and pycnidia."

"The thallus supports the apothecium, which is the most important part of the plant."

"There are many organs, all of which must be examined under the microscope, and these have been the subject of profound study and discussion many years, but especially since the microscope came into use. On them many fanciful theories as to the origin of lichens, whether they are autonomous or not, have been built."

"However grand the Schwendener theory, the question of autonomy is still open, while new discoveries are being made which may eventually change the whole aspect of the science."

The 125 forms included are not merely listed, but are briefly described. The bulletin concludes with a bibliography of "North American Lichenology," which is said to be nearly complete, about 120 titles being cited.

NOTES AND NEWS.

THE SYNONYMY of certain Yuccas is presented by Dr. C. S. Sargent in *Garden and Forest* (March 11th), which involves giving a new name, *Y. mohavensis*, to the *Y. baccata* Engelm., not Torrey.

PARTS 131–133 of *Die natürlichen Pflanzenfamilien*, just issued, are entirely the work of Dr. Engler himself, presenting *Rutaceæ*, with 111 genera, *Simarubaceæ*, with 28 genera, and the beginning of *Burseraceæ*.

THE FOLLOWING North American plants have been figured recently in *Garden and Forest:* Nolina recurvata (March 4th), Lippia iodantha (March 11th), Nymphaea tetragona (April 1st), Oreodoxa regia (April 15th).

IN THE MARCH number of *Bulletin de l'Herbier Boissier* Tonduz continues his interesting account of the flora of Costa Rica; and Freyn publishes another fascicle of new or noteworthy oriental plants, chiefly Liliaceæ.

A NEW East Indian species of Phytophthora, (*P. Nicotianæ*) which produces a serious disease of tobacco is described and figured by Dr. J. v. Breda de Haan in "Mededeelingen uit 's lands Plantentuin," XV (Batavia, 1896). The species seems allied to *P. Cactorum* if one may judge from the plate, but the spores are smaller, measuring about $36 \times 25 \mu$. Both conidia and oospores are described.

MR. A. K. MLODZIANSKY publishes in *Garden and Forest* (March 4th) some interesting results of observations on the rate of growth of "loblolly pine." The height growth reaches its usual limit (95^{ft}) in 90 years; the second decade showing the most rapid rate. The diameter growth shows the most rapid rate during the first decade; while the mass accretion increases continuously in rate until between 100 and 110 years, at which time this pine reaches its maximum growth.

MR. GEORGE MASSEE has published (*Jour. Bot.* April), with plate, descriptions of certain new or critical fungi. *Clypeum* (*Hysteriaceæ*) is proposed as a new genus from New Zealand. Several of the new species are from the United States, and the generic name *Spragueola* is proposed for a New England fungus communicated by Isaac Sprague to Berkeley and referred by him to *Mitrula*, regarding it the same as *Spathularia crispata* Fr. It now stands as *S. Americana*.

MICHIGAN AGRICULTURAL COLLEGE observed Friday, May 1st, as Arbor Day, by public exercises, which included addresses by President J. L. Snyder and His Excellency John T. Rich, Governor of Michigan; also by Dr. R. C. Kedzie, who spoke on "The early forests of Michigan," by Mr. A. A. Crozier, on "Michigan forests of to-day," and by Dr. W. J. Beal, on "What now should be done with our forests?" The exercises were interspersed with appropriate music.

MR. F. H. KNOWLTON announces in *Science* (April 17th) the discovery of an American amber-producing tree. The material described was obtained from Cape Sable, Maryland, but was in such an imperfect state of preservation that nothing very satisfactory could be ascertained as to its relationships. Mr. Knowlton provisionally refers it to *Cupressinoxylon*, dedicating the species (*Bibbinsi*) to Mr. Arthur Bibbins who explored the locality. The association of amber with the tree seems undoubted.

N. Alboff, in *Bull. Herb. Boiss.* (Feb.), has given an account of the forests of Western Transcaucasus. His conclusions, in brief summary, are: 1. The forest flora of Western Transcaucasus, although evidently allied to that of the Mediterranean, yet differs from it considerably. For this reason it should be regarded as a special modification of the latter. 2. It does not vary equally throughout the whole extent; at the south passing imperceptibly into the typical Mediterranean flora through a transition province (Turkish Lazistan); at the north passing more or less abruptly into the flora of southern Crimea.

The Columbine Association has been organized with the purpose of securing the official adoption of the columbine as the national flower. Mr. Frederick Le Roy Sargent, of Cambridge, Mass., is president. He has prepared a neat illustrated booklet setting forth the claims of the columbine to official recognition as the national flower, which are many and strong. Among the council we observe the names of a number of well-known educators, artists and architects, who warmly endorse these claims. Copies of the leaflet may be had for three cents by addressing the secretary, Mr. J. S. Pray, box 2774, Boston.

Miss Susan G. Stokes, of Stanford University, California, has collected a large number of seed plants upon a trip through the mountains back of San Diego, which she offers for sale in sets of 325. The route followed was from San Diego sixty miles due east along the boundary of Lower California; seventy-five miles north through the mountains, crossing an arm of the desert at Warner's Hot Springs and San Felipe; from Smith Mt. to Soledad, where are the few remaining trees of *Pinus Torreyana* Parry. A great many of the species obtained are limited in distribution and not a few are from type localities.

In his "Studies upon the Cyperaceæ," begun in the *American Journal of Science* for May, Mr. Theo. Holm calls attention to the monopodial branching of certain of our species of Carex, notably the species of Laxifloræ. As American students of Cyperaceæ seem to have disregarded this character it is perhaps as well to state the simple way by which sympodial and monopodial branching may be recognized in Carex: "The sympodial shows us a central flower-bearing stem, the base of which is surrounded by more or less faded leaves from the previous year; while the monopodial shows a central leafy shoot with a number of laterally developed flower-bearing stems."

The next meeting of the American Association for the Advancement of Science, will be held in Buffalo, N. Y., commencing on Monday, August 24, 1896, and adjourning on Friday the 28th. Each section is invited this year to make out its special program, and in order that these may be printed for distribution in advance, it is requested that titles and abstracts of papers to be presented in Section G (Botany) be transmitted to the Secretary of the Section, Prof. Geo. F. Atkinson, Cornell University, Ithaca, N. Y., not later than July 1, 1896. Those who intend reading papers will confer a great favor upon the Association by heeding this notice.

PROFESSOR E. L. GREENE'S *Pittonia* has again appeared (May 1st), the present number being Vol. iii, Part 13. It contains the "Nomenclature of the fullers' teasel," a curious and just now pertinent question; a new cruciferous genus, *Sibara*, to include certain Mexican and south Californian species heretofore variously referred to Cardamine, Arabis, Nasturtium, and Sisymbrium; more than thirty "New or noteworthy species;" a new genus of *Polemoniaceæ*, *Langloisia* by name, to include a small group of southern desert annuals variously referred to Gilia, Laeselia, and Navarretia; and four new Mexican species of Compositæ of the Eupatorium group, being from Pringle's distributions.

THE SECOND ANNUAL meeting of the Botanical Society of America will be held in Buffalo, New York, on Friday and Saturday, August 21 and 22, 1896. The council will meet at 1:30 P. M. on Friday, and the society will be called to order by the retiring president, Dr. William Trelease, Director of the Missouri Botanical Garden, at 3 P. M. The president-elect, Dr. Chas. E. Bessey, Professor of Botany in the University of Nebraska, will then take the chair. The afternoon session will be devoted to business. At the evening session the retiring president will deliver a public address on "Botanical Opportunity." The sessions for the reading of papers will be held on Saturday at 10 A. M. and 2 P. M.

IN *Bull. Herb. Boiss.* (Feb.) J. Briquet, the new Curator of the Delesster Herbarium and Director of the Botanic Garden of Geneva, givesan account of the herbarium and garden. In the case of the former the exsiccati and their dates are listed. The garden is evidently making good use of its modest resources, in 1895 no fewer than 3,095 species being in cultivation. M. Briquet also contributes to the same number a biographical sketch, accompanied by portrait and bibliography, of his predecessor Jean Müller, known to systematists as "Muell. Arg." Müller's studies among phanerogams and lichens are well known. He was especially an authority upon that enormous and difficult family *Euphorbiaceæ*, which he contributed to De Candolle's Prodromus.

MESSRS. LONGMANS, GREEN & CO., have in the press "Diseases of Plants due to Cryptogamic Parasites," translated from the German of Dr. Carl Freiherr von Tubeuf, of the University of Munich, by William G. Smith, B. Sc., Ph. D., Lecturer on Plant Physiology to the University of Edinburgh. The original work appeared at the beginning of last year. It considers all investigations on the subject up to that time. In addition to a systematic treatment of the parasitic cryptogams, the first part of the book (100 pp.) is devoted to consideration of the general relationship of parasite to host, to methods of culture of fungi, and to a *résumé* of combative and preventive measures.

With the assistance of the author, the translator proposes to adapt the work for use in English-speaking countries, and to add the results of the more important recent investigations. New figures to supplement the original will be added, bringing the number to over 300.

AMONG THE biographical memoirs issued by the National Academy of Sciences that of Dr. Engelmann, by Charles A. White, has just appeared. The various memoirs of Dr. Engelmann already published had put on record his botanical work and many of the facts of his life. The present memoir, however, adds certain new biographical features in that the author had access to an autobiography written for the son, Dr. George J. Engelmann. The more one studies the life and work of Dr. Engelmann the more is he impressed by the unwearied patience, the prodigious capacity for work, and the keen and critical insight of the man. The debt which North American botany owes to him has not yet been fully appreciated.

IN THE *New England Magazine* for March there appears a very interesting paper, by Mr. James Ellis Humphrey, entitled "Botany and Botanists in New England." Prefacing his account with an entertaining description of Parkinson's *Theatrum Botanicum* and Josselyn's writings, the author begins with Manasseh Cutler as the first New England botanist. Cutler is certainly one of those botanists much of whose deserved reputation unfortunately died with him. His writings were voluminous, but chiefly remain as manuscript volumes, and they show a keenness of insight that was remarkable at the time and would have ranked him among the first of American botanists. Then follow accounts of Nuttall, Bigelow, Amos Eaton, Dewey, the brothers Boott, Hitchcock, Emerson, Oakes, Pickering, Gray, Wright, Watson, Robbins, Morong, Russell, Tuckerman, Frost, Olney, James, and D. C. Eaton, certainly a worthy list. The publication of numerous portraits also makes the paper especially interesting to botanists.

THE "MESCAL BUTTON" is yielding some very interesting results in the direction of its physiological action. It is the little cactus of the Lower Rio Grande region variously referred to Mamillaria, Anhalonium, and Echinocactus, and recently separated as a distinct genus under the name Lophophora. It has long been held as a sacred plant by the Indians of its region, and the "mescal ceremony" is one of the most interesting of savage rites. The *Therapeutic Gazette* for January contains an account of its therapeutic uses, by Dr. D. W. Prentiss and Dr. F. P. Morgan, and the ceremony connected with it, by Mr. James Mooney, of the U. S. Bureau of Ethnology. It seems to be a remarkable sedative, as well as a cerebral stimulant, without any of the unpleasant effects of the opium group. Its power in the production of visions of color is probably its most striking physiological effect. Mr. Mooney says: "So numerous and important are its medical applications, and so exhilarating and glorious its effect, according to the statements of the natives, that it is regarded as the vegetable incarnation of a deity, and the ceremonial eating of the plant has become the great religious rite of all the tribes of the southern plains." There may still be some question as to its identity, however, if it is, according to Mr. Mooney, "a small cactus, having the general size and shape of a radish, and covered on the exposed surface with the characteristic cactus prickles." While the size and form given apply to Lophophora, that genus is characterized by not possessing "the characteristic cactus prickles."

Dr. Gy. de Istvanffi is preparing an elaborate work upon Clusius the founder of mycology. Charles de l' Escluse, or Carolus Clusius, began his collection of the plants of Hungary and adjacent regions in the latter half of the sixteenth century and in 1583 published a classical work under the title "Rariorum aliquot stirpium per Pannoniam, Austriam, et vicinas quasdam provincias observatarum historia." A few years later he turned his attention to the larger fungi. Under the patronage of Baron Bathasar de Batthyány, Clusius undertook frequent excursions in Hungary. On the observations and notes made in these regions he based his treatise entitled "Fungorum in Pannoniis observatorum brevis historia," published in 1601. For this work eighty-six water colored plates were prepared by a skilled artist under Clusius' direction which are now preserved as Codex no. 303 in the library of the University of Leyden. Dr. Istvánffi has carefully studied this Codex and has published some preliminary notes upon it. The new folio work will contain the text of the "Fungorum historia;" the eighty-six water colors in fac simile by chromolithography; a biographical sketch, illustrated by views, letters, autographs, etc.; together with the result of his extensive studies of this material from the mycological standpoint. It will be issued in ten fascicles each containing eight or nine colored plates, with the text in Hungarian and French. The price of each fascicle will be $3.15, subscriptions being received for the complete work only. After publication the price will be $45. Subscriptions may be sent to Dr. Gy de Istvánffi, chief of the department of botany of the National Hungarian Museum, Budapest V., Széchengi-uteza 1. II. 17.

From a recent circular of the Division of Forestry, U. S. Department of Agriculture, we take the following regarding our forest resources. After premising the want of exact forestry statistics, Mr. Fernow says:

The forest area of the United States (exclusive of Alaska) may be placed at somewhat less than 500,000,000 acres. This does not include much brush and waste land which is, and will remain for a long time, without any economic value. Seven-tenths of this area are found on the Atlantic side of the continent, one-tenth on the Pacific coast, another tenth in the Rocky mountains, and the balance is scattered over the interior of the western states. Both the New England states and the southern states have still fifty per cent. of their area, more or less, under forest cover, but in the former the merchantable timber has been largely removed. The prairie states, with an area in round numbers of 400,000 square miles, contain hardly four cent. of forest growth, and the 1,330,000 square miles—more than one-third of the whole country—of arid or semi-arid character in the interior contain practically no forest growth economically speaking.

The character of the forest growth varies in the different regions. On the Pacific coast, hardwoods are rare, the principal growth being coniferous and of extraordinary development. Besides gigantic red-woods, the soft sugar pine and the hard bull pine, various spruces and firs, cedars, hemlocks, and larch form the valuable supplies. In the Rocky mountains no hard woods of commercial value occur, the growth being mainly of spruces, firs, and bull pine, with other pines and cedars of more or less value. The southern states contain in their more southern section large areas occupied almost exclusively by pine forests with the cypress in the bottom lands; the more northern portions are covered with hardwoods almost exclusively, and intervening is a region of mixed hardwood and coniferous growth; spruces, firs, and hemlocks are found in small quantities confined to the mountain regions. The northern states are mainly occupied by hardwood growths, with conifers intermixed, sometimes the latter becoming entirely dominant, as in the spruce forests of Maine, New Hampshire, or Adirondacks, and here and there in the pineries of Michigan, Wisconsin, and Minnesota, or in the hemlock regions of Pennsylvania and New York.

The amount of timber standing is, roughly, 2,300,000,000,000 ft., board measure, while the total annual cut is estimated at 40,000,000,000 ft., of which three fourths is pine and the rest hardwood. The total wood consumption is about 50 cu. ft. per acre, a figure nearly corresponding to the yield per acre realized in the well-kept forests of Prussia where reproduction is secured by skillful management. Forest products stand easily second in value to agricultural products, exceeding mineral products by more than 50 per cent. The annual loss by fire is estimated at $25,000,000.

BOTANICAL GAZETTE

JUNE, 1896.

Contributions from the Cryptogamic Laboratory of Harvard University. XXXV.

New or peculiar aquatic fungi. 4. Rhipidium, Sapromyces, and Araiospora, nov. gen.

ROLAND THAXTER.

WITH PLATES XXI–XXIII.

Of the numerous aquatic forms the discovery of which we owe to the researches of Cornu, the four species which he placed in the genus Rhipidium[1] are among the most interesting from their striking peculiarities as well as from the fact that, as far as the writer is aware, they have been observed by no other botanist. It is true that Cornu regarded the Naegelia of Reinsch as identical with one of his species of Rhipidium; but, as has been mentioned in a previous note,[2] it seems quite unlikely that this is the case. Owing to the fact that Cornu's account, which was avowedly a preliminary one, has not been supplemented by any details or figures, with the exception of certain illustrations in Van Tieghem's Traité de Botanique, it is impossible to form any very accurate idea of the essential differences which separate the species; and for the same reason the true limitations of the genus itself are by no means clear. The difficulty is further increased from the fact that the figures just mentioned do not correspond to the description of the species represented in one very important respect, so that in view of this uncertainty both as to generic and specific characters, the writer

[1] Cornu, Monographie des Saprolégniées. Ann. d. Sci. Nat. Bot. V. **15**: 15 ff. 1872. Also Bull. Soc. Bot. de France **18**: 58. 1871.

[2] Bot. Gazette **19**: 50. 1894.

has felt obliged not only to describe under a new name the common American species, but to modify the limitations of the genus as described by Cornu.

In general terms *Rhipidium* Cornu may be said to be characterized as possessing a highly developed basal cell, attached to the substratum by rhizoids, which gives rise terminally to a number of filaments successively constricted and bearing sexual and non-sexual reproductive organs. The sexual organs consist of oogonia in which single oospores are produced as a result of fertilization by an antheridium, peculiar from the fact that it always penetrates the oogonium at a definite point on the surface of the latter. The sporangia are more or less oval in form and emit the zoospores in a cylindrical mass surrounded by a thin membrane which ruptures almost immediately, allowing them to escape.

Such in general are the characters of the genus as originally described; and in regard to the species, a comparison of the scattered references which one finds in the "Monograph" affords the following information.

Rhipidium interruptum, as appears from the figures and description of Cornu, has oval sporangia, the filaments being characterized by the presence of numerous constrictions and sympodially (not otherwise) branched below the successively formed terminal sporangia; the segments cylindrical, short, six to eight times as long as broad. The oogonia are spherical and correspond in position to the sporangia, the oospore solitary, "étoilée" or "munie de crètes très saillantes."[3] The antheridia are heterogenous, borne at the tips of long and twisted filaments and apply themselves near the base of the oogonium,[4] although in the figure given in Van Tieghem[5] they are represented as being applied near the apex.

R. continuum is described as resembling the preceding species in all respects except that the filaments are continuous, the only constrictions present being those which separate them from the basal cell and from the reproductive organs.

R. elongatum differs from the two preceding species in that the successive segments of the filaments are clavate and very long, attaining a length sometimes of a millimeter. The surface of the oospore is, moreover, undulate, and the antherid-

[3] Cornu, Monograph l. c. pp. 15 and 103.
[4] op. cit. p. 30.
[5] Traité de Bot. 1024. *fig. 617*.

ial filament is spirally twisted below the antheridium, which applies itself to the apex of the oogonium by means of a terminal beak-like process. Whether the filaments are umbellately or otherwise branched is not mentioned.

R. spinosum, the fourth and last of the species described, is still more imperfectly known; but may be distinguished from the others by the fact that its sporangia are furnished with stout spines directed upwards and downwards, and are borne sub-umbellately at or near (?) the tips of the segments.

If one compares this fragmentary information, which, although it is perhaps sufficient to distinguish these four species from one another, is quite inadequate to afford a means of separating them from other allied forms, it becomes apparent that, although the two first, together with the American species subsequently described, are undoubtedly congeneric, the others are by no means certainly so. The characters of *R. elongatum* in particular, so far as we are informed concerning them, when compared with those of the species of Sapromyces, indicate a generic identity which can hardly be doubted. On the other hand the characters of *R. spinosum* suggest a similar identity with the generic type described below as Araiospora. To make these points more clear a brief review of the chief characters of the three genera just mentioned will be necessary.

The genus Rhipidium, if we limit it as above indicated to the three species *R. interruptum*, *R. continuum* and *R. Americanum*, is characterized by a differentiation, more extreme than in the other instances to be described, between its monstrously developed basal cell and the often very numerous filaments to which it gives rise. This basal cell is distinctly *sui generis*, and although it may be variously modified from the fact that it is often more or less regularly branched or lobed, is utterly different in character from the segments of the branches to which it gives rise. Its walls are usually greatly thickened and it is, as a rule, very abruptly expanded distally; its lower extremity being fastened to the substratum by numerous rhizoids. From the edges or from the upper surface of the expanded portion, from which they are separated by a constriction, are produced the filaments; and on the latter are borne the reproductive organs. These filaments, as in other members of the Leptomitaceæ, are characterized by a segmentation which, as we have seen, is very well marked in *R. interruptum;* while in *R. continuum* the whole filament constitutes a single segment. In *R. Americanum*, on the other hand, we have a transitional form, in which the filament may consist of one or of several segments. The filaments themselves are in all the species apparently simple, although in reality they consist of a succession of sympodial branches which arise below each sporangium after it has formed, the further upward growth of the branch causing the sporangium, though really terminal, to assume an apparently lateral position. This type of filament is distinctly characteristic of the genus as limited above; and, although it occurs neither in Sapromyces nor in Araiospora, is identical with that which is present in the ordinary sporangiferous filaments of Apodachlya. The sporangia, as has just been mentioned, are terminal, and are typically solitary, although they may, especially in rather depauperate specimens, occur several together at the extremity of a filament. Several, however, often succeed one another at intervals on the same filament (fig. 5). The form of the sporangia, although in *R. Americanum* it shows a considerable degree of variation (figs. 7 and 15), tends, in specimens that have developed under favorable conditions, to assume the characteristic shape represented in fig. 6; and the same peculiarity is noticeable in the published figure of *R. interruptum.*

The sporangia produce a comparatively small number of rather large zoospores, which are peculiar not only from their appearance, but from the manner in which they make their escape. As the sporangium matures, a broad and conspicuous papilla is formed at its summit (fig. 7), and its wall is evidently double; for when the zoospores are ready to emerge, the outer wall splits around the base of this papilla which is then carried upwards at the extremity of the emergent mass of spores (fig. 8), remaining attached to the inner wall which also surrounds the spore mass. The latter makes its exit in the form of a cylindrical column (fig. 9) which may reach a length equal to twice that of the sporangium before the thin surrounding wall becomes ruptured, usually at the side (fig. 10), allowing the zoospores (fig. 11) to escape. This process only occurs when the plant is growing under favorable conditions, and very often the inner wall may burst at once, turning the cap to one side and allowing the spores to escape directly from the cavity of the sporangium. The zoospores are biciliate, much flattened, bean-shaped, with a slight indentation on one side, near which the cilia are attached, and are composed of large refractive granules (fig. 11) which give them so characteristic an appearance that they are always recognizable at a glance when seen swimming about in company with other zoospores. This peculiar method of egress is described by Cornu as characteristic of *R. interruptum* and his figure of the zoospores of this species represents the same coarsely granular structure. The zoospores are monoplanetic and in *R. Americanum* only the first stages of germination have been observed. The figures given in the Traité de Botanique[6] illustrate their further development in *R. interruptum*, and indicate that the body of the zoospore itself gives rise directly to the expanded portion of the basal cell, the hypha of germination forming the stalk and producing the rhizoids from its apex. The spore thus develops as it were upside down.

The oogonia are formed like the sporangia, but are usually, if not invariably terminal, and are similarly distinguished from the filaments which bear them by the characteristic constriction. They are almost perfectly spherical in form and contain a single large oosphere which is not readily distinguishable from the rather abundant peripheral protoplasm until after fertilization has been accomplished. The antheridial filament in the American species, which, unlike the two European forms, is androgynous, arises immediately below the insertion of the oogonium; and is usually very short and slender (figs. 13 and 14), seldom, if ever, exceeding the length represented in fig. 12. The antheridium is rather small and rounded, though abruptly distinguished, and applies itself close to the base of the oogonium, the wall of which it perforates without indentation. The two European forms differ not only from the fact that they are heterogynous, but on account of the much greater development of the antheridial branches which are said to be "fort allongés et volubiles."[7] The point at which the antheridium applies itself to the oogonium in these species, although, as has been already mentioned, it is represented as towards the summit in the figure given in the Traité de Botanique (*fig. 617, 1a*), may be assumed to be at the base, as in *R. Americanum*, in accordance

[6] Traité de Botanique 1024. *fig. 617. 2.*
[7] Cornu, Monograph 28.

with the statement on p. 30 of the Monograph: "le point ou se fixe l'anthéridie semble assez constant: c'est vers la base chez les *R. continuum* et *interruptum.*"

As the oospore matures the peripheral protoplasm begins to contract around it producing an undulate outline, and as it hardens in forming the exospore, the contained oospore follows its outlines, becoming later quite spherical through the deposition of its proper wall. The undulate outline assumed by the peripheral protoplasm seems to be due, in part at least, to the fact that it adheres to the inner wall of the oogonium, and when it begins to shrink away from the latter, the adherent areas form the "crests" characteristic of the exospore after it has become entirely freed from this attachment. Cornu appears to lay great stress on the alleged fact that the oosphere is itself originally undulate, and that this contour is reproduced in the mature spore. This, however, does not seem to be the case in the American form; the oosphere, when first distinguishable, being evenly spherical. The mature oospore is very thick walled and colorless in the species. Its germination has not been observed.

Such are the characters which seem to the writer to distinguish the genus Rhipidium in its restricted sense. Turning now for a moment to the genus Sapromyces, a more detailed description of which may be found in the paper previously cited, it will be seen that in general habit it differs from Rhipidium from the fact that, although the whole plant arises from a single cell attached by rhizoids to the substratum (fig. 16), this cell is undifferentiated and similar, except at its base, to the segments of the filaments; although its wall is often considerably thickened. In comparing the type of branching also, it is evident that it is fundamentally different, the whole plant being a several times compounded umbel, as regards the origin of the branches as well as that of the reproductive organs. The sporangia are characteristically elongate in form and the oogonia are definitely piriform and subject to external encrustation. The two known species including that subsequently described are in the one case androgynous, in the other heterogynous; the antheridial filament in both cases being peculiar from the fact that it becomes spirally twisted below the curved, oblong to cylindrical antheridium; which is also peculiar in that it applies itself to the oogonium near the apex of the latter, which it perforates as the result of a definite pressure by which the wall becomes distinctly indented. The species previously described (*S. Reinschii*) has been observed by the writer in great abundance and in perfect condition since the publication of the note above mentioned, and in specimens growing under favorable conditions the emission of the zoospores has been seen to be similar to that of Rhipidium except that the membrane surrounding the emerging spore mass is ruptured almost immediately, so that all but a small number of the spores escape in the usual way through the open mouth of the sporangium. In this genus the zoospores are like those of the Saprolegniæ in general appearance, and are quite unlike those which have just been described as occurring in Rhipidium.

If we compare these characters with what few data are available concerning *Rhipidium elongatum* it is apparent that, although we know nothing as to its type of branching, it strikingly resembles the species of Sapromyces in other essential points. Its antheridial branch "présente presque invariablement, au-dessous de l'anthéridie, un tour de spire, sorte de boucle incomplétement formée. Ce fait ne se présente que dans cette espèce, et il est très constant."[8] And further, "Dans le *Rhipidium elongatum* l'anthéridie a une forme spéciale; elle est oblongue, courbe, et porte à son extrémité un bec recourbé: c'est par ce bec seulement qu'elle touche à l'oogone."[9] Again "le point ou se fixe l'anthéridie semble assez constant: c'est vers le sommet chez *R. elongatum.*"[10] Lastly "le prolongement" (from the antheridium) "repousse la paroi de l'oogone, et finit par la perforer comme par suite d'une pression considerable (*Rhipidium elongatum*)."[11]

If now we examine the characters of the genus described below as Araiospora, it is apparent that it represents a transitional form between Rhipidium on the one hand and Sapromyces on the other. In general habit it resembles Rhipidium from the fact that its basal cell, unlike that of Sapromyces, is very greatly enlarged; although it is evidently a mere modification of a segment like those of the branches, which, as we have seen, is not the case in Rhipidium; while its type of branching and the form of its ordinary sporangia correspond exactly to those of Sapromyces. The oogonia, however, as

[8] Cornu, Monograph 29, note.
[9] op. cit. 31.
[10] op. cit. 30.
[11] op. cit. 40.

well as the antheridia, resemble those of Rhipidium, being spherical, without encrustation, and containing an abundant peripheral protoplasm. The antheridia, also, are exactly like those of Rhipidium, and apply themselves to the oogonium in the same position and in the same way; perforating the wall without indentation. On the other hand the genus differs from either of the other two in possessing two kinds of sporangia, one of which is identical with the type found in Sapromyces, as has been already mentioned, the other quite different in shape and furnished with numerous prominent spines; while the oospore is unique from the fact that it becomes surrounded by a cellular envelop derived from the peripheral protoplasm. The antheridial filaments, moreover, arise from special segments which are always derived from the same segment that produces the oogonia which they fertilize, and grow downward to the base of the latter, often producing one or more branches, each terminated by an antheridium.

In view of the presence of spinose sporangia borne more or less umbellately, it seems not improbable that the fungus just described may be very properly considered, at least provisionally, as generically identical with *Rhipidium spinosum;* since all we know of this species from the figures given by Cornu is that the sporangia may be oval to oblong and spinose,[12] or piriform and unarmed,[13] and that they may be sub-umbellately borne.[14]

In view of the various distinctions above enumerated, a provisional summary of the members of the Leptomitaceæ may be indicated as follows; the group being separated as a distinct family in accord with the classification adopted by Schroeter in his revision of the Phycomycetes.[15] It may be said, however, that should the family be united with any other, it must evidently be with the Pythiaceæ, if we recognize them as distinct from the Peronosporaceæ, or with the latter if we do not; since their reproductive processes coincide with those of the two last mentioned families rather than with those of the Saprolegniaceæ. It will be observed that in the following synopsis, Gonapodya has been retained in the family, where, in the writer's opinion, it may be provisionally placed

[12] op cit. *pl. 5. figs. 4* and *9.*
[13] l. c. *figs. 1* and *2.*
[14] l. c. *fig. 6.*
[15] Engler und Prantl, Naturl. Pflanzenfam. 93: 101. [Th. I. Abth. 1.]

until we have more definite information by means of which its true position may be finally determined; and also that the form described by Humphrey as *Apodachlya completa* has been omitted, in view of the fact that the non-sexual reproduction of this remarkable plant was not observed and that the nature of the sexual process described must remain a matter of great uncertainty until further observations can be made upon it.

LEPTOMITACEÆ.—Filaments segmented through the presence of successive constrictions. Oogonia containing a single oosphere surrounded by periplasm.

?GONAPODYA.—Typical segments short and broad. Sporangia pod-shaped, successively several times proliferous. Zoospores 1-ciliate (always ?).

Two species: *G. siliquaeformis* (Reinsch) Thax., Europe and America; *G. polymorpha* Thax., America.

LEPTOMITUS.—Filaments slender branched, the segments long cylindrical. Non-sexual reproduction effected by the conversion of a terminal or of several superposed segments into zoosporangia which are but slightly if at all differentiated. Oospores unknown.

One species: *L. lacteus* Ag., Europe and America.

APODACHLYA.—Filaments simple or sparingly branched. Sporangia terminal, or originally terminal, becoming apparently lateral through the sympodial branching of the segments which bear them, broadly oval or piriform and distinctly differentiated from the segments. Zoospores becoming encysted, as in Achlya, immediately after their exit from the sporangium (always ?), diplanetic. Oospores unknown.

Two species: *A. pirifera* Zopf, and *A. brachynema* (Hild.) Prings. (probably synonymous), America (Thaxter) and Europe.

RHIPIDIUM.—Plant consisting of a monstrously developed basal cell distinct in character from the segments of the numerous filaments to which it gives rise, distally expanded and either simple lobed or branched. The filaments apparently simple, but monopodially branched below the originally terminal sporangia. Zoosporangia for the most part solitary, broadly oval, the zoospores biciliate, composed wholly of coarse refractive granules, emerging from the sporangia in a cylindrical mass surrounded by a thin membrane and surmounted by the papilla of dehiscence; monoplanetic, swarming as soon as freed by the rupture of the surrounding membrane. Androgynous or heterogynous, the oogonia spherical, containing a thick-walled oospore. The antheridia small, applied to the oogonium near its base, the pollinodium perforating the wall without indenting it.

Three species: *R. interruptum* Cornu, *R. continuum* Cornu, Europe; *R. Americanum*, nov. sp. America.

Araiospora, nov. gen.--Plant consisting of a greatly enlarged basal cell attached by rhizoids from its base, and similar in character to the segments of the filaments which arise often in considerable numbers from its distal extremity. Filaments repeatedly umbellately branched, cylindrical or nearly so. Zoosporangia arising from the distal end of the segments in whorls or umbels of two kinds, the one smooth, the other differently shaped and furnished with prominent spines. Zoospores finely granular, biciliate, monoplanetic, emerging in a mass at first surrounded by a thin membrane which ruptures almost immediately. Oogonia in whorls or umbels, often associated with the zoosporangia, spherical, separated from the segment, like the zoosporangia, by a constriction. Oospores solitary, thick-walled, surrounded by a cellular envelop derived from the periplasm. Antheridial branches arising from special segments, simple or branched, the small rounded antheridia applying themselves close to the base of the oogonium.

Two species: *A. pulchra*, nov. sp., America; (?) *A. spinosa* (Cornu), Europe.

SAPROMYCES.—Plant arising from a basal cell attached by rhizoids from its base and resembling in all respects the segments of the filaments which arise in small numbers from its apex. Filaments as in Araiospora. Zoosporangia rather elongate, sub-cylindrical or broadly clavate. Zoospores as in Araiospora. Oogonia borne in whorls or umbels, piriform, often encrusted. Oospores solitary, thick-walled. Androgynous or heterogynous, the antheridial filaments arising distally from the segments, the portion immediately below the antheridium twisted on itself. Antheridium long oblong, curved, applying itself to the apex of the oogonium by means of a beak-like process by which the wall of the latter is indented before perforation.

Three species: *S. Reinschii* (Schroeter) Fritsch, America and Europe; *S. androgynus*, nov. sp., America; *S. elongatus* (Cornu), Europe.

The new species above alluded to may be characterized as follows:

Rhipidium americanum, nov. sp.—*Plate XXI, figs. 1–15.*

Basal cell very variable in form and size, attached by copious rhizoids; above more or less regularly one or more times successively dichotomously branched or lobed, the lobes or branches erect or spreading in a radiate fashion, the upper or external edges giving rise to numerous filaments from which they are distinguished by the characteristic constrictions. The filaments continuous or less frequently consisting of two or three sub-clavate segments. Sporangia typically ovoid tapering from the broad base to the bluntly rounded apex, but varying greatly in form, erect, originally terminal, one to four succeeding one another on a single filament; rarely two or three borne together terminally. Oogonia terminal, spherical, the thick-walled oospore colorless, the exospore elevated in a series of anastomosing ridges which give the spore an irregularly stellate outline. Antheridial filaments short, slender, arising immediately beneath the oogonium from the same segment; the antheridium small, rounded, applied close to the base of the oogonium. Basal cell 75 to 400μ long. Filaments 50 to 800μ long, seldom longer. Sporangia 30×20 to $86 \times 27\mu$, average $50 \times 35\mu$. Oogonia 40–55μ. Oospores 30–45μ in diameter.

On various decaying vegetable substances in ponds and ditches, vicinity of Cambridge, Mass., and of Kittery Point, Maine.

This species is by no means uncommon in the localities mentioned and may be obtained throughout the season from April to September, though more abundant in the late spring and early summer. It is remarkably variable and were it not that intermediate forms showed every imaginable gradation between such extremes as are represented in figs. 2 and 3 it would not be difficult to separate it into at least two species. The differences in habit as well as in the form of the sporangia seem largely due to the surroundings under which the individual has developed, and the nutritive character of the substratum on which it grows. On sour green apples for example one almost always obtains the form represented in fig. 3 and it is only in such rather depauperate specimens that I have observed the occurrence of more than one terminal sporangium. Such forms are also much more likely to produce oospores, and their zoosporangia are also subject to the greatest amount of variation both in form and in size.

Like Blastocladia, with which it is very often associated, it usually grows under rather unfavorable conditions, being surrounded by a mass of bacteria and other foreign organisms and under these circumstances it is apt to assume abnormal and irregular forms. Under such conditions the discharge of the zoospores, which is in any case a very rapid process, is usually not accomplished in the characteristic fashion above described, through the rupture of the inner membrane at the moment of dehiscence. The filaments are far more commonly unsegmented, and each sympodial branch is as a rule distinctly clavate in form, tapering towards its point of origin just below the sporangium. The oogonia in all observed instances have been terminal and as a rule are formed after the production of zoospores has begun to cease. The species is more closely allied to *R. continuum* than to *R. interruptum* and may prove identical with it when the former has been intelligibly described. The dichotomous branching of its basal cell, and its androgynous character as well as its very short antheridial filaments serve to distinguish it in the absence of further knowledge of the European form.

Araiospora pulchra, nov. sp.—*Plate XXIII, figs.* 20–25.

Basal cell variably developed, usually large, sub-cylindrical, the ramiferous extremity sub-conical, bearing often numerous (forty or less) acropleurogenous branches in a more or less distinctly umbellate fashion and separated from it by the usual constrictions. The branches composed of more or less cylindrical segments and repeatedly umbellately branched, the segments sub-cylindrical becoming more slender and usually longer as they succeed one another. Sporangia borne in whorls or umbels, sub-cylindrical or broadly clavate, and smooth; or broadly oval to piriform and furnished with large spines radiating in all directions but sometimes short and stout and confined to the distal extremity. Oogonia borne like the sporangia, the constricted portion which separates them from the segment very short. Oospore spherical, the thick wall colorless, surrounded by a single layer of more or less hexagonal peripheral cells derived from the periplasm. Basal cell 1 to 1.5^{mm} long by 50–25μ. Filaments 2750–275μ long. Sporangia 120×30–175×35μ average 125×30μ. The spinose forms about 45–60×48–70μ the spines 10–35μ long.

Oogonia 50–60μ. Oospores 35–45μ. Peripheral cells about $7 \times 10\mu$.

On submerged sticks in ponds and ditches, vicinity of Cambridge, Mass., and of Kittery Point, Maine.

This strikingly beautiful form is very common in the vicinity of Cambridge and may be found in abundance at almost any time during the late spring and summer. It is subject to considerable variation as regards the relative development of the basal cell and of the filaments arising from it. In some cases the latter are branched not more than once or twice as is represented in fig. 20, and in such instances the oogonia greatly outnumber the sporangia. In other cases the filaments are far more highly developed being many times successively branched, the branches growing more slender and usually longer as they are successively formed, and bearing many more zoosporangia than oogonia. It is in such individuals that the spinose sporangia most frequently occur and often greatly outnumber these of the ordinary type. The cellular envelop of the oospores remains about them after the oogonium wall has disappeared, and may be seen to consist of distinct cells. The latter are slightly inflated and the wall of the oospore follows the contour of their inner margins. The species seems to differ from the *Rhipidium spinosum* of Cornu from the different shape of its sporangia and from the fact that in the spinose form the spines are radiate and not directed "en haut ou en bas."[15] Nevertheless the species, like the Rhipidium just described, may yet prove synonymous with the European form.

Sapromyces androgynus, nov. sp.—*Plate XXII, figs. 16–19.*

Like *S. Reinschii* though somewhat smaller. The oogonia piriform, sometimes encrusted by a blackish scaly deposit. Oospores spherical, the thick colorless wall more or less modified by the presence of elevations which sometimes give it a roughly undulate outline. Antheridial branches arising close to the base of the oogonium from the same segment, a spiral twist usually present below the antheridium which applies itself to the apex of the oogonium and is similar in form to that of *S. Reinschii*. Total length 500–1000μ. Zoosporangia about $75 \times 26\mu$. Oogonia $27–30 \times 35–50\mu$. Oospores 20–26μ.

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[15] Cornu, Monograph 15.

On submerged sticks in ponds and ditches, vicinity of Cambridge, Mass.

This species is not uncommon about Cambridge, but I have never found it growing in any very great abundance. It almost invariably produces oospores and its androgynous character is constant. It differs from *S. Reinschii* in its smaller habit, in the modification of its exospore, which, however, is not always very pronounced, and especially in the origin of its antheridial branch which in the last mentioned species always arises at a distance from the oogonium, a fact that has been established by the examination of abundant material collected about Kittery Point.

Harvard University, Cambridge, Mass.

Explanation of Plates XXI–XXIII.

Rhipidium americanum Thaxter.

Fig. 1. General habit of a more typical plant, the basal cell dichotomously thrice-lobed, the filaments showing occasional segmentation.

Fig. 2. General habit of a much branched specimen bearing both oogonia and zoosporangia.

Fig. 3. A radiately branched depauperate plant seen from above, the zoosporangia not yet mature.

Fig. 4. Lobe of a depauperate plant with mature filaments.

Fig. 5. Portion of the margin of the lobe of a basal cell showing the origin of several filaments and the whole of a single filament bearing three sporangia, two of them empty.

Fig. 6. Zoosporangium of typical form.

Fig. 7. Zoosporangium of typical form in which the zoospores and the papilla of dehiscence have been formed.

Fig. 8. Sporangium killed at the moment of dehiscence. Showing a portion of the spore mass extruded, surrounded by its envelop and terminated by the papilla of dehiscence.

Fig. 9. Dehiscent sporangium just before the rupture of the envelop surrounding the spore mass which is still terminated by the papilla of dehiscence.

Fig. 10. The same a moment later. The envelop has broken at the right allowing the zoospores to escape. The papilla of dehiscence is still attached to the envelop.

Fig. 11. Zoospores, the lowest in dorsal view.

Fig. 12. Oogonium, the periplasm in process of forming the exospore.

Fig. 13. Mature oospore in oogonium, the former seen in surface view.

Fig. 14. Mature oospore in oogonium, seen in optical section.

Fig. 15. An abnormal form of sporangium common in depauperate individuals.

Sapromyces androgynus Thaxter.

Fig. 16. General habit of a small plant bearing both oogonia and zoosporangia.

Fig. 17. Group of zoosporangia, two of them empty.

Fig. 18. Oogonium during fertilization, before the antheridial filament has become twisted.

Fig. 19. Group of two oogonia with mature oospores and twisted antheridial filaments.

Araiospora pulchra Thaxter.

Fig. 20. General habit of an oosporiferous plant of medium size.

Fig. 21. Terminal portion of a basal cell bearing several filaments with oogonia and both varieties of zoosporangia.

Fig. 22. Two sporangia, producing zoosporangia similar to the spinose type, in which the spines are absent or undeveloped.

Fig. 23. Segment bearing two typical spinose sporangia and one of the ordinary form, one of the spinose form emitting its zoospores and shown in optical section.

Fig. 24. Segment bearing an antheridial segment and two oogonia, one seen in optical section, the other represented in surface view.

Fig. 25. Portion of segment bearing an antheridial segment and an oogonium in which the peripheral cells are in process of formation.

*** NOTE. The figures are photo-lithographed from ink drawings and reduced about one-third from the originals. The approximate magnifications in diameters are as follows: Figs. 1 to 3, × 50. Figs 4, 16, 20, 21, × 90. Figs. 5, 22 to 24, × 240. Figs. 6 to 15, 17, 18, × 320. Fig. 25, × 925.

Contribution to the life-history of Sequoia sempervirens.

WALTER ROBERT SHAW.

WITH PLATE XXIV.

Sequoia sempervirens Endlicher and *S. gigantea* Decaisne are the only living representatives of a once larger and very widely distributed genus of the Coniferæ. Each species is limited to a narrow natural distribution in California. We have no account of the development of the sexual generation (prothallium), our knowledge of the reproduction in this genus being limited to accounts of the development of the flowers[1] and the germination of the seed[2] of *S. sempervirens*. The arboretum of Leland Stanford Junior University contains a large number of young fruiting trees of the latter species. It also lies within the zone of distribution of the species, there being one tree one hundred and forty feet high on the university grounds. At the suggestion of Dr. Douglas H. Campbell a study of the development of the macrosporangia (ovules) and the prothallia by microtome methods was begun in November, 1891, and carried on under his direction. The publication of the results was several times delayed in hope of being able to make them more complete.

The material for study was collected from young trees in the arboretum of Stanford University during the season of 1891–92. Collections were made in December, 1891 (not dated), and from January 9 to July 5, 1892, at intervals of three to seven days. The young flowers were split longitudinally, and the sporophylls were removed from the older flowers. The specimens were fixed in 1 per cent. chromic acid for eighteen hours, washed in water, and transferred gradually to 90 per cent. alcohol. For sectioning the alcoholic material was stained *in toto* in Czokor's alum-cochineal and imbedded, through the medium of turpentine, in paraffin. The sections were cut on a Minot microtome, stained on the slide with a solution of Bismarck brown in 70 per cent. alcohol, and mounted in Canada balsam.

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[1] Strasburger, Die Angiospermen und die Gymnospermen 85. Jena, 1879.
[2] Strasburger, Die Coniferen und die Gnetaceen 327. Jena, 1872.

The female flower.

About the first of December, 1891, it was found that the macrosporangiate (female) flowers on larger trees were more advanced in development than those on the smallest trees which bore flowers. The sporophylls (cone scales) of these flowers are closely arranged spirally on an axis which is at this time about 4^{mm} in length, and are surrounded by scale leaves which are borne lower down on the same axis. Each macrosporophyll consists of a shorter basal portion perpendicular to the axis of the flower, and a longer terminal portion, closely appressed and parallel to the axis of the flower (compare figs. 6 and 7). On the ventral (upper) side of the basal portion is a transverse row of macrosporangia one to eight or ten in number, most numerous on the middle sporophylls of each flower. The middle sporangium on each sporophyll has its axis nearly parallel with, but slightly inclined toward, the floral axis. In the terminal portion of the sporophyll there is a resin-duct (*r* in figs. 6 and 7) along the dorsal (lower or outer) side of the single fibrovascular bundle. The abrupt bend between the basal and terminal parts of the sporophyll is somewhat thickened transversely in all directions. The sporangia are cylindrical and about as long as broad (figs. 1 and 2), and the integument reaches to a level with the flat top of the sporangium.

Just as the flowers had closed in February, Mr. B. M. Davis collected a hermaphrodite flower. In this flower the upper sporophylls are macrosporangiate and like those of the female flowers, and five of the lower sporophylls are microsporangiate (male) and, with the exception of the upper one which is in form like a female sporophyll, are similar to those of the regular male flowers. The relative positions of the two kinds of sporophylls is the same as the relative positions which the two kinds of flowers occupy on the branches of the tree; the female flowers are formed on the terminal shoot and neighboring twigs of each fertile branch, and the male flowers on the lateral twigs of the same branches. And correspondingly the lower branches of the tree bear more male than female flowers.

Early in January the microsporangiate flowers shed their pollen and the macrosporangiate flowers open to receive it. The opening of the flowers, male as well as female, consists in a separation of the sporophylls by intercalary growth of the floral axis accompanied by an elongation of the basal portion of each sporophyll. The growth of the axis is greatest between the lowest sporophyll and the upper scale leaves, so that the flower is carried out of its envelope. In the macrosporangiate flower the basal part of the axis is negatively geotropic at this time and the flower assumes a more or less upright position. Open flowers were collected for about a month during which time the integument grows out beyond the sporangium forming a vestibule into which a thick fluid substance is excreted. In this the pollen grains are caught and held. About the time when the flowers open, the transverse thickening in the bend between the basal and terminal portions of the sporophyll begins to increase. This thickening develops in all directions nearly at right angles to the basal portion of the sporophyll and by it the flower is closed. This growth involves also that part of the base of the sporophyll which bears the sporangia and by it the sporangia are inclined toward the floral axis (figs. 6 and 7). When the flowers close, early in February, the middle sporangia on each sporophyll are about half way turned toward the axis, and about the first of March the micropyles are directed toward the floral axis. In the thickened part of the sporophyll secondary resin-ducts are developed and in the base of the sporophyll fibrovascular bundles are formed which end beneath the sporangia.

The cones continue to grow until about the first of June, at which time they are 21–24^{mm} in length and 15–17^{mm} in thickness. The cones open by shrinkage of the fleshy, obconical, middle portion of the sporophyll, which takes place at the end of the summer, in September, or later in the same year.

The macrosporangia.

In the young flowers the macrosporangia are circular in cross section and the integument reaches up to a level with the flat top of the sporangium. The sporangium is about as long as broad. The integument consists of the inner and outer epidermis and two layers of hypodermal cells. About the time the flowers open, January 1st, the integument begins to exceed the sporangium in length, and when the flower closes, about a month later, the integument is about twice as long as the sporangium. The micropyle then begins to close by radial elongation of the integument epidermal cells about it. In this way the pollen grains on the flat circular top of the sporangium become enclosed in a subconical cavity, the micropyle. About the time when the micropyle begins to close, the hypodermal tissue of two opposite sides of the integument begins to grow in a radial direction to form the wings of the seed. In some cases the thickening of the integument occurs on three or four sides, in the directions of least resistance, but only two wings are developed. About the middle of February, when the micropyle has closed, the hypodermal cells in that part of the integument which surrounds it develop thick pitted walls which appear to be lignified (fig. 5, *e*). Up to this time the sporangium has grown slowly and it now begins to elongate by growth of the chalazal portion (fig. 3). The seed reaches its full length and width in June, when it is about 5^{mm} wide by 6^{mm} long.

In December the sporangium is cylindrical in form and about as long as broad, and surrounded by the integument which reaches about to the same level. Within the epidermis are five to seven central longitudinal rows of cells surrounded by one or two layers of smaller cells which are also arranged in longitudinal rows. Each of the central rows of cells appears to have originated in a single cell immediately beneath the epidermis, and the rows extend from the apex of the sporangium nearly to the chalaza, in which no regular arrangement of the cells can usually be traced. In the earliest stage observed the central rows consisted of two or three cells (fig. 1). Later stages show several cells in each row, of which the innermost, larger and longitudinally elongated, with a large nucleus, is a sporogenous cell, and the others are tapetal cells which are often somewhat flattened in shape with smaller and lenticular nuclei (fig. 2). During January the sporangium elongates slightly and there come to be about six tapetal cells between each sporogenous cell and the epidermis at the micropyle (fig. 3, *b*). About the first of February, after pollination has been effected, the growth of the sporangium becomes limited to the region between the sporogenous cells and the chalaza. The tapetum anterior to and alongside the sporogenous cells undergoes no farther growth and the cell walls of the anterior tapetum become somewhat thick and firm. By the basal growth of the sporangium the sporogenous cells come to occupy a position relatively near the apex of the sporangium (figs. 4, *c*, and 5, *e*). About the middle of March the cells immediately about the base of the somewhat enlarged sporogenous cell or cells begin to weaken and disorganize (fig. 4, *d*), and each sporogenous cell divides twice to produce four macrospores (fig. 5, *f*). The first division is transverse and the second, which follows before the first wall develops to any thickness, is transverse in the lower cell and either transverse, oblique, or longitudinal in the upper cell.

The female prothallium.

A number of spores begin at once to develop female prothallia. They increase in length and grow toward the chalaza at the expense of the cells which lie in their paths, and the growing end of each becomes gradually larger. After about three weeks, April 8th, sacs are found with two nuclei (fig. 8, *h*). Already one sac is considerably larger than the others. The elongation of the sporangium continues and the embryo-sacs grow rapidly in length. Usually the largest sac in a sporangium grows down through the center of the sporangium, and the smaller ones grow obliquely or spirally downward alongside the larger one. By the middle of April there are eight or sixteen nuclei in the largest sac, all located near the lower or growing end of the sac, and the rest of the sac contains little protoplasm. One or even more of the smaller sacs may contain as many nuclei as the larger sac and they also are collected near the lower end (fig. 9). As the sacs elongate, the nuclei become more numerous and are distributed in a peripheral layer of protoplasm which line the whole length of each sac. About the end of May the longest sac reaches to the chalaza and the lower two-thirds or three-fourths becomes thicker. Usually the smaller sacs are confined to the upper third or quarter of the sporangium where they become tangled and surround the upper part of the principal sac. This upper part of the principal sac becomes atrophied and does not develop tissue. The formation of the cellular prothallium in the sac was not observed but it takes place about the first of June. When this occurs all or nearly all of the tissue of the sporangium has been absorbed except the epidermis and those cells which were anterior to the sporogenous cells. The upper part of the sporangium containing the secondary sacs and the "suspensor" of the primary sac becomes shriveled and bent. The cells of the prothallium usually show an arrangement in radial rows but do not always. The cells in the upper end are as a rule larger than those in the lower end.

The date of maturation of the archegonia seems to vary as much as a month. The archegonia are numerous and usually arranged radially in the upper half or third of the prothallium, sometimes distributed to the upper end and sometimes not. They are, then, as a rule lateral. Only a few preparations showed the archegonia. In these the archegonia were nearly as long as half the transverse diameter of the prothallium and each consisted of a small neck cell and a large egg-mother cell (fig. 10, *s*, *t*). The farther development of the archegonia remains to be studied.

By July 5th the central part of the upper half of the prothallium contains several intertwined tubular suspensors each with an eight- or twelve-celled embryo on the lower end (figs. 11 and 12). The origin of the proembryos (suspensors with embryos) could not be traced in the sections. From prothallia macerated for a few hours in 10 per cent. caustic potash suspensors were obtained by dissection. They are unicellular and each contains a rather large nucleus near the middle, or the lower end. In nearly every case the wall of the upper end is ruptured as if by the penetration of a pollen-tube.

The pollen-tube.

At the time the pollen is shed in January each grain contains two apparent cells, a larger vegetative cell with a large nucleus, and a smaller, lenticular, parietal cell with a smaller nucleus. The germination of the pollen begins soon after the middle of February, and by the end of the third week in that month the pollen-tube reaches across the flat top of the sporangium and begins to grow down between the sporangium and integument. The vegetative nucleus passes into the tube and is usually to be found between the middle and the growing end of the tube. There is more variation in the rate of development of the pollen-tubes than of the principal embryo-sacs. During March the tube may reach half or two-thirds the length of the small sporangium and quite as often as not it branches, one branch growing on downward and the other taking any direction between the sporangium and integument, or penetrating the epidermis of the sporangium. About the time when the tube enters the sporangium the antheridial cell in the microspore enlarges and its nucleus divides (fig. 8, *i*, Apr. 8th). The two daughter nuclei, which are smaller than the vegetative nucleus, move together into the tube. In a number of preparations these two nuclei were seen a short distance behind the vegetative nucleus near the place where the tube penetrates the sporangium wall. After entering the sporangium the tube passes obliquely downward and enlarges considerably. It soon becomes impossible to distinguish it in sections from the numerous windings of the several variously developed embryo-sacs with which it intertwines; and so it was not traced to the mature female prothallium. A study of the sectioned material is often made still more confusing by the fact that one or more of the secondary embryo-sacs with their free nuclei sometimes escape from the sporangia and grow around, up or down inside the integument. These are however larger than the pollen-tubes. An attempt was made to isolate the older pollen-tubes by macerating the sporangia in 5 per cent. and 10 per cent. caustic potash solutions but without success. It was found that this method showed clearly the course of the tubes before entering the sporangia but not farther. Some sectioned specimens show with little doubt that the pollen-tube usually or at least frequently grows down alongside the female prothallium, but as some of the secondary embryo-sacs with free nuclei often do the same thing nothing more definite was learned.

In some cases several of the embryo-sacs develop tissue, and again the single large prothallium may appear as several in sections by reason of constrictions produced by other immature sacs or by pollen-tubes.

The peculiarity of the pollen-tubes is that they do not penetrate the wall of the sporangium in the immediate neighborhood of the micropyle but at lateral points in the upper fifth of the sporangium. In this respect, and in the distinctly branched form which the tube develops,[3] Sequoia bears at least a remote resemblance to some of the so-called chalazogamous angiosperms.

With respect to the numerous archegonia and their irregular distribution in the prothallia we have in Sequoia an exceptionally generalized type of conifer. The division of each sporogenous cell into four macrospores, and the prolonged development of the secondary embryo-sacs, are characters as primitive as any we find among the Coniferæ. The abortion of the upper fourth or fifth of the principal embryo-sac into a

[3]S. Nawaschin, Botanisches Centralblatt **63**: 355. 1895.

suspensor-like structure the author does not know to occur in any other of the Gymnospermæ. The knowledge obtained of the development of the sporangia and prothallia indicates that the Taxodineæ have been very properly, if *Sequoia* is a fair type of the family, considered as a most primitive group of modern Coniferæ.

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EXPLANATION OF PLATE XXIV.

Fig. 1. Longitudinal section of sporangium with integument. × 266. About Dec. 1, 1891.

Fig. 2. Longitudinal section through sporangium with integument, showing three sporogenous cells. × 266. About Dec. 10, 1891.

Fig. 3. *a*, longitudinal section through sporangium and integument. × 36. *b*, sporangium in same section showing three sporogenous cells. × 176. Feb. 16, 1892.

Fig. 4. *c*, longitudinal section through sporangium and integument. × 36. *d*, sporangium of same section showing one sporogenous cell. × 178. March 14, 1892.

Fig. 5. *e*, longitudinal section through sporangium with integument. × 34. *f*, sporangium of same section showing eight macrospores just formed from two sporogenous cells. × 180. March 14, 1892.

Fig. 6. Longitudinal section through sporophyll showing position of sporangium; the resin-duct, *r*, does not appear in its full length in this section. × 21. January 17, 1892.

Fig. 7. Median longitudinal section through sporophyll; *r*, resin-duct. × 21. January 17, 1892.

Fig. 8. *h*, longitudinal section through sporangium with male prothallia (pollen-tubes) and an embryo sac with two nuclei; the broken line indicates the course of a tube as followed in a different section, the tube being entirely outside of the sporangium; a nucleus at the point where the tube branches, and two nuclei in the antheridial cell; also two nuclei in the larger embryo sac. × 90. *i*, pollen spore of the same tube, drawn from two sections, showing the divided antheridial cell. × 154. April 8, 1892.

Fig. 9. Longitudinal section through a sporangium containing an embryo-sac with sixteen nuclei in the lower end, of which five appear in the section; two smaller sacs which wind about the larger one are cut in oblique section, one of the smaller sacs contains about sixteen nuclei, of which three appear in the section. × 41. April 15, 1892.

Fig. 10. Archegonia from a longitudinal section of a prothallium; *s*, from about one-fourth the length of the prothallium from the anterior end; *t*, about three-eighths from the anterior end. × 110. About June 21, 1892.

Fig. 11. Section of an embryo of eight cells from a longitudinal section of a prothallium; *x*, *y*, *z*, indicate the order of the sections. × 172. July 5, 1892.

Fig. 12. Longitudinal section through prothallium enclosed in sporangium of which the upper one-fourth is shrunken and occupied by abortive embryo-sacs; the upper half of the prothallium contains suspensors with embryos; *k* is the embryo section of fig. 11 *x*. × 15. July 5, 1892.

All drawings sketched with an Abbé camera lucida.

Notes concerning the development of Nemalion multifidum.

GRACE D. CHESTER.

WITH PLATES XXV AND XXVI.

The resemblance between the structure of the frond and the development of the cystocarp in the genera Batrachospermum and Nemalion is close enough to have led the earlier writers to place them in the same order, and this has also been done by Schmitz in his latest revision of the Florideæ.

Through the researches of Sirodot it has been well established that there is a protonema or chantransia-stage resulting from the germinating spores of Batrachospermum. The surmise in regard to a protonematoid stage in the development of Nemalion also, made by Dr. Farlow in his "Marine Algæ of New England,"[1] has suggested the desirability of making an effort to trace the growth of the spores of this plant. The fortunate discovery of young Nemalion plants, together with an abundance of mature fronds, in the region of Woods Hole, Mass., led the writer during the summer of 1893 to attempt to obtain some further knowledge of this subject.

As far as the writer knows, up to the present nothing in regard to the germination of Nemalion has been published.

The only spores of which we know anything definitely are carpospores. Dr. Farlow quotes Agardh in regard to the presence of tetraspores in the genus Nemalion and says that "no tetraspores have been seen on American specimens of *Nemalion multifidum*."[2] In this same connection it is said by Bornet and Thuret that they have never found tetraspores on any member of the Nemalieæ.[3]

The mature plants of *Nemalion multifidum* Duby consist of slender gelatinous fronds of a deep red-purple color. They often rise with numerous others from a slightly expanded base, which in the older plants is clean and sharply cut, but in the younger is often very irregular in outline. The plants are found attached to rocks or to the shells of barnacles. The

[1] Farlow, W. G., Marine Algæ of New England 116.
[2] Farlow, W. G., op. cit. 117.—Harvey, Nereis Bor. Am. **2**: 134.
[3] Bornet & Thuret, Etudes Phycologiques 65.

fronds are from one millimeter to about forty centimeters in length, and from one to three millimeters in diameter. Dichotomous branching is the rule, but irregular branching may be found at various points. Branches occur with more frequency near the tip of the frond where the gelatinous sheath is thinner and where the central filaments can easily make their way to the outside. The writer has never found new branches arising near the very bases of old fronds. The appearance of a tuft of fronds as if all arising from one point, which is frequently seen on barnacle shells, is due to the fact that the young frond sometimes divides very early in its growth into several branches, separated by short intervals, and the expanded base is common to all these branches.

In order to study the earliest development of the Nemalion plants, it was necessary to devise some method of cultivating the spores. For this purpose shallow dishes were used, upon the bottom of which glass slides were placed. A gentle stream of sea-water ran constantly into the dishes, and the water was drawn off from the bottom of each dish over the edge by a siphon. Fronds possessing mature cystocarps were laid over the slides and the spores were shed upon the slides in large numbers. Other spores were collected upon slides placed in dishes which were not supplied with running water. In this case the water was very carefully drawn off and renewed four to five times every day. Spores obtained in this way were watched daily from the 1st until the 12th of August, 1893. The spores, immediately upon being shed, attached themselves to the slides, so that it was possible to keep the same spores under continuous observation, verifying in individuals the changes which were shown in a series of plants. The best results in growth were obtained from the slides which had not been supplied with running water, which was contrary to expectation, since the plants investigated grew on rocks that were exposed to strong buffeting of the waves.

The attached spore is spherical, 12μ to 14μ in diameter, with a stellate chromatophore situated nearly in the center. Bands of granular cytoplasm extend from the cytoplasmic substance surrounding the chromatophore to the peripheral layer of cytoplasm lining the cell wall. There appears to be a double wall to the spore, the inner one thin, while the outer one is firm and thick. Both walls are colorless and transparent. The chromatophore appears as a single body, occupying a large portion of the cell and the deep red color of the whole cell is due to its presence. The nucleus of the spore and of the other cells of the plant is not visible in cells untreated by reagents and hence is not shown in any of the figures of this paper. Figure 1 shows the characteristic form and position of the chromatophore in a freshly attached spore.

The spore itself after remaining apparently unchanged for about twenty-four hours begins to elongate. It extends a protuberance at one end; the chromatophore a little later takes up its position near the tip of this elongating portion and is accompanied by nearly all the cytoplasm of the spore. The protuberance is next separated from the original spore portion by a transverse wall. At this stage, therefore, the sporeling consists of two cells, one a basal almost empty cell, the original spore, and the other, somewhat smaller, ellipsoidal in form (fig. 2). The original spore cell, which loses its chromatophore and a large part of its cytoplasm when the new cell is formed, persists for some time, after gradually losing its contents, as an empty spore-case (figs. 3, 4, 12, 13).

From the newly formed cell there arises in each case, by repeated division, a filament of cells branched or unbranched, each cell of which is similar to the one from which all have originated (figs. 3, 5, 6, etc.).

In many cases branches arise while the sporeling is still very young. Fig. 7 shows the first indication of such a branch in the protrusion of the process *a*. Fig. 8 shows a similar process, *a*, in a later stage, and in fig. 6 there is shown at *a* such a process completely cut off from the parent cell. The branch cell thus formed may contain a chromatophore (fig. 7, *a*), in which case the cell proceeds to divide, forming a series of cells (fig. 9, *a*, *b*), or it may be destitute of a chromatophore, and in this case it develops into a hair. Fig. 6, representing a plant seven days old, shows a typical cell of this sort at *a*.

The sporeling may also form a flat expansion of cells by branches developing in double rows from the original chain of cells as is shown in fig. 9, to which reference has already been made. This bears a decided resemblance to the more advanced structures found at the base of the Nemalion fronds attached to the barnacle shells where they grow. Fig. 10 shows one typical plant of this sort, many of which form red spots on the barnacles, suggestive of the similar spots described by Dr. Farlow as occurring at the base of the fronds of *Mesogloia divaricata* Kütz., which, as also suggested by him, have a definite connection with the growth of the mature frond of that plant.[4]

After the sporeling has developed from three to ten rounded cells, cells of a decidedly different type are developed in the continuation of the filament. These are long, narrow and contain less dense cytoplasmic contents and smaller, less deeply colored chromatophores (figs. 13, 14, 15). In fig. 13, the rounded cells are followed by elongated forms which at *b* are surmounted by two cells which have developed as buds from this last cell of the filament, *b*, and this is the first case of the development of dichotomous branching in the sporeling. From this elementary stage of branching are traced in other sporelings more advanced stages, showing degrees of perfection of dichotomous and of fascicled branching, approaching more and more in their appearance the fascicled branches of the filament of the mature frond, to be described later. Figs. 13, 14, 15 and 12 show such a series, taken from numerous plants of similar structure.

The basal processes of these sporelings are of interest at this point. Fig. 13 shows three of these cells extending back of the spore, *a*. Fig. 14 shows two such processes and three marked branches or rhizoidal processes are found in fig. 15, *a*, *b*, *c*. These are similar to the branched rhizoidal growths formed abundantly at the bases of mature Nemalion plants, and these latter growths are doubtless identical in formation with these sporeling processes.

Fig. 14 is the most interesting form in this series, as the fasciculate branching at its tip shows certain unbranched or single arms, *b*, *b*, *b*, *b*, which, by increase in length, may meet and twist together, forming the elementary condition of a mature frond. These arms would later divide and produce dichotomous fascicles with occasional single arms, which would continue in the manner of the early sporeling to increase in length and thus increase the frond in length and diameter.

In order to throw some light on this very point of the growth of the mature plant in its earliest stage, the growth of the tip of the frond, showing the method of increase in length of the whole plant, was next investigated. The gelatinous mass, which surrounds every filament of the plant, makes it

[4] Farlow, W. G., Marine Algæ of New England 84.

difficult to see the real structure of the tip region. The tip may be seen, however, by directly crushing the frond. This removes too many of the branchlets or disturbs too much their relative position. The application of boiling water to dissolve a large amount of the gelatinous substance allows us to examine the tip with every axial filament and branch in its natural position.

The tip of the plant is never conical. The number of axial filaments and their branches is so great even in the youngest plants examined, that extreme care is necessary to distinguish those occupying the exact tip. It is certain that no single filament at the tip exceeds the others in size, and that there are present at the extreme tip of the plant a number of filaments almost exactly alike (fig. 11). The smallest number of filaments possible to trace to the very tip was three (fig. 11), the lower filaments and the final branchlets of each filament having been gradually removed by gently crushing the plant which had been treated with hot water.

Turning now to the adult frond below the tip, we find that it is made up of distinct axial and cortical layers. Each of these layers is made up of branching filaments. In the axis the filaments are made up of long narrow cells, from 30 to 125μ in length, containing small colorless chromatophores (fig. 11, *a*, *b*). The walls marking the cell divisions of these threads are so far apart (often 125μ) as to have made Agardh's statement[5] a most natural one. "The filaments proceeding downwards are inarticulate and cylindrical; those growing upwards are articulated, and more or less contracted at the dissepiments." These central cells divide at irregular intervals, giving off, often without separation by a cell wall, branches which may proceed undivided in the central region or turn towards the periphery, and divide dichotomously (fig. 11, *c*, *d*). Several divisions of a central thread may occur at very short intervals as shown in fig. 11, where five such arms are separated off from the main thread near *e*. Certain of these arms proceed up or down the main axis for a long distance without dichotomous branching, *d*, *f*. Fig. 14 shows the origin of the single arm, as we shall call it, at *b*, *b*, *b*, *b*, together with the other arms or branches which directly form the perfect fascicle. The "downward growing" arms turn to the periphery as much as do the "upward growing" arms, and

[5] Harvey, Nereis Bor. Am. 134.

form fascicles of branches by dichotomous division (fig. 11, *g*).

Thus tracing these different filaments to the tip, we find at the very last three main axial threads (fig. 11, *1*, *2*, *3*) bearing lateral fascicles and ending in three distinct fascicles, *4*, *5*, *6*, each bearing single arms, *7*, *8*, *9*, like those formed lower down on the frond. These single arms, *7*, *8*, *9*, by their increase in length will extend upward beyond the divided arms or fascicles of branches, and by later division increase the length of the whole frond.

Increase in diameter is produced by the pushing to the periphery of direct or lateral branches of the axial filaments. These divide dichotomously to form new fascicles (fig. 11, *c*, *g*, etc.). Very young tufts are thus found with fully fruited ones at the base of even the oldest fronds. Young undeveloped trichophores are found in the next fascicle to one bearing ripe cystocarps. Agardh's description of the mode of the development of the Nemalion frond is interesting, at this point.[6]

Agardh states that the frond consists of three regions, "central, lateral and peripheral." The peripheral branches grow first, and send their branches inward, making the increase in diameter of the frond "like that of an endogenous tree from the outside to the inside."

A definite resemblance between the structure of the tip of the frond and the sporeling tip both in respect to the fasciculate branches shown in detail in figures 12, 13, and 14, and in respect to the single arms or unbranched filaments occurring with these (figs. 14, *b*, *b*, *b*, and fig. 11, *7*, *8*, *9*,) is clearly seen. Both of these conditions have been already described. The possibility of the development of the erect or mature frond from the sporeling plants must now be noticed. The increase in length and subsequent division of any of the filaments of a sporeling plant to form a complete frond has already been mentioned (fig. 14). The meeting of several

[6] "The different strata of the frond seem to me to be formed in an opposite direction. First, unless I am deceived, the peripheric stratum begins to be developed from the base upward by progressive evolution; some of the branches emitted by the peripheric filaments constitute the peripheric stratum, but others are erected with a direction more vertical, giving off on their outer side new peripheric filaments, and on their inward side longitudinal filaments. These latter, at first, by an ob ique course are directed towards the center of the axis; then they take a downward direction, by a longitudinal course. In some respects, therefore, the growth of an endogenous stem is imitated."

such sporeling plants and the consequent interlacing of the filaments belonging to each seems a very probable method of formation for a plant with the axial structure of Nemalion. It also seems probable that the increase in length of the filaments developed on any of the plants found on the barnacle shells which there form red spots (fig. 10), the subsequent division into branchlets, and the interlacing of these filaments may give rise to an erect frond of Nemalion. The possible origin of Mesogloia from similar "spots" has already been mentioned.

In conclusion I would compare or homologize the prostrate series of rounded cells developed from a spore of Nemalion forming a short filament or a flat expansion of cells with that series of prostrate cells formed from the Batrachospermum spore and called by Sirodot a prothallus or protonema, and described by him as such in "Les Batrachospermes." The resemblance seems so exact as to admit of calling this stage in Nemalion also a protonema. From this there arises the branched sporeling already described. The chantransia stage of Batrachospermum is an erect plant, branching irregularly and bearing the sexual plant as a bud. This sexual plant has an axis of single cells placed end to end, covered by the branches which grow up and down its surface. In Lemanea, the chantransia is a similar branching plant, bearing the sexual plant as a bud. The resemblance between this stage in Lemanea and Batrachospermum and the branched sporelings described in this paper is so close as to admit of calling these branched sporelings the chantransia stage of Nemalion.

It remains my pleasant privilege to thank Dr. W. A. Setchell of the University of California for his suggestive direction of the work done on Nemalion at the Marine Biological Laboratory, at Woods Hole, Mass., in 1893, for material collected by him in 1894, and for criticism during the development of these observations.

Smith College, Northampton, Mass.

Explanation of Plates XXV and XXVI.

Plate XXV.

Fig. 1. Carpospore of *Nemalion multifidum*. × 400.
Fig. 2. Spore in early stage of germination; three days old. × 400.
Fig. 3. Sporeling in later stage of germination (protonema); three days old. × 400. *a*, empty spore case; *b*, second cell of plant; *c*, colorless protuberance developing into third cell of the plant.

Fig. 4. Another common form of sporeling or protonema; three days old. × 400.

Fig. 5. Characteristic filamentous sporeling or protonema; five days old. × 400.

Fig. 6. Branched protonema with hair cell, *a;* seven days old. × 400.

Fig. 7. Filamentous protonema showing origin of branch, *a;* nine days old. × 400.

Fig. 8. Filamentous protonema with branching process, *a,* further developed; nine days old. × 400.

Fig. 9. Protonema forming flat expansion of cells; ten days old. × 400.

Fig. 10. Protonema with seven branches forming flat expansion on barnacle shell. × 400.

Plate XXVI.

Fig. 11. Tip of frond crushed to remove extra filaments and tip branchlets. × 130.

Fig. 12. Detail of typical lateral or tip fascicle of mature frond. × 240.

Fig. 13. Filamentous growth from sporeling showing first indication of dichotomous branching. × 240.

Fig. 14. Older sporeling or "chantransia" stage, with perfect fascicle of branchlets and well developed rhizoidal branches. × 240.

Fig. 15. Chantransia more advanced than the preceding, with several rhizoidal branches. × 240.

*** Figs. 1–9 from nature, with Abbé camera. Material under cultivation in 1893.

Fig. 10 from nature, with Abbé camera. Material on barnacle shell.

Figs. 13–15 with Abbé camera. Material cultivated in 1894 by Dr. Setchell and preserved in chrome-alum.

Synopsis of North American Amaranthaceæ. V.

(Concluded.)

EDWIN B. ULINE AND WILLIAM L. BRAY.

IRESINE L. Gen. Pl. n. 1113. 1737.

Lithophila Sw. Prod. Veg. Ind. Occ. 14. 1788.

Philoxerus R. Br. Prodr. Flor. Nov. Hol. **1**: 416. 1810.

Tromsdorfia Mart. Nov. Gen. et Spec. Bras. **2**: 40. 1826.

Hermaphrodite, polygamo-diœcious or diœcious herbs, shrubs or shrubby trees, the latter attaining a height of six meters, with opposite usually petioled leaves, scarious whitish 3-bracted flowers crowded into clusters or spikes in a branching paniculate inflorescence: calyx of five sepals which in ☿ and ♀ flowers are generally almost hidden in long wool which springs from the base of the flower: stamens five; filaments united into a shallow cup at base and bearing staminodia in most species: utricle globular, ovate or urn-shaped with short style and two slender often filiform stigmatic branches.

In this synopsis of the genus *Iresine* we have followed the plan stated previously of including such Mexican and Central American species as were found to be well represented in the herbaria of the United States, so that while we reduce the forms found in the United States to *Iresine vermicularis* (L.) Moq. and *Iresine paniculata* (L.) Kuntze, with its two varieties, there are here included some eleven other tolerably well defined species from Mexico and Central America, four of which we venture to describe as new, knowing well that a more thorough acquaintance with the Iresines of those regions may show us to be in error. As a matter of interest we would call attention here to the rather surprising fact that from Honduras and Guatemala Iresines are reported which are actually shrubby trees and in one case a small tree six meters in height.

* *Hermaphrodite.*

+ *Inflorescence capitate.*

IRESINE VERMICULARIS (L.) Moq. DC. Prodr. **13²**: 340. 1849.

Gomphrena vermicularis L. Sp. 224. 1737. no. 6.

Philoxerus vermicularis R. Br. Prodr. Flor. Nov. Hol. **1**: 410. 1810.

Low fleshy seaside herbs with narrow sessile leaves, capitate inflorescence and ☿ flowers: sepals five, unequal, the flower flattened dorso-ventrally: stamens five, staminodia none.

Florida, West Indies, Guiana, Brazil; also on lower Rio Grande and in Panama.

On the supposition that the specimens examined were accurately named, this will embrace *Iresine portulacoides* (St. Hil.) Moq. l. c. and *Iresine aggregata* (Willd.) Moq. l. c. With our present view of Iresines, the descriptions in DC. Prodr. **13**[2]: 340, 341 do not indicate satisfactory specific differences.

+ + *Inflorescence paniculate.*

Iresine completa, n. sp.

Shrubby, with rather dense appressed grayish pubescence: leaves long and narrow elliptical-lanceolate, glabrous except the under surface of young and midrib of older leaves, these and the stem blackish in the dried specimens: inflorescence a narrow panicle with short strictly opposite branches and branchlets, each pair subtended by short acute scarious bracts, or by reduced leaves lower on the main axis; spikelets pedicellate in the axils of bracts, or terminal on the ultimate branchlets: flowers ☿, rather large, 2.5^{mm} long, bracts broadly ovate, less than half the length of the perianth: calyx with glabrous sepals, nerved and with scarious margins, on a distinct pedicel from which arises a dense growth of long woolly hairs: utricle as in the next species, from which this differs in its complete hermaphroditism, pubescence and narrower inflorescence with opposite arrangement: stamen cup rather deep and the staminodia prominent.

Honduras, San Pedro Sula, *Dr. Carl Thieme* no. 338 (1888). Type in John Donnell Smith herbarium.

IRESINE ELATIOR Rich. in Willd. Sp. Pl. **4:** 766.

Rosea elatior Mart. Nov. Gen. et Spec. Bras. **2**: 59. *pl. 155.* 1826.

Stem herbaceous, erect, striated, glabrous: leaves oblong-lanceolate and narrower: panicle pyramidal; spikelets alternate, short pedicellate; flowers ☿: staminodia present but very minute: utricle orbicular.

Mexico, Lower California, Central America, West Indies.

* * *Polygamo-diœcious.*

+ *Shrubs or shrubby trees.*

Iresine nigra, n. sp.

Shrubs, sometimes shrubby trees, undergrowth in forests, turning black on drying, glabrous except among the flowers: leaves much as in the preceding but thicker, smaller and with longer petioles: inflorescence a lax panicle with very long, slender alternate branches loosely set with small spikelets, which are pedunculate only at the base of branches: flowers sometimes ☿, but apparently generally unisexual by failure of pollen or ovules to mature, some plants being prevailingly pistillate, others staminate: bracts and sepals in ☿ and ♀ flowers as in the preceding, but the flowers are smaller, 1.5^{mm} long; in those flowers which are more conspicuously staminate the sepals are longer, narrowly oblong, somewhat pilose, but the woolly growth from the base is inconspicuous: utricle top-shaped, narrowed below into a stalk-like base and above into a short style with two long filiform stigmatic branches: staminodia very minute.

Honduras, San Pedro Sula, *Dr. Carl Thieme* nos. 312, 314 (1888) 1061, 38 (1887); Guatemala, *Heyde & Lux* 4573 (1893); Orizaba, *Botteri* 990. Types in J. D. S., Coulter, and Gray herbaria.

Iresine arbuscula, n. sp.

A small tree 4.5 to 6^{m} high with large oblong-elliptical green leaves $14–21^{cm}$ long including petiole $3–4^{cm}$ long; branches and petioles black in dried specimens: inflorescence a pedunculate naked drooping panicle at the ends of leafy branches, the larger branches of the panicle subtended by scarious bracts, never by reduced leaves as in *I. paniculata* which it resembles considerably in inflorescence; branches of inflorescence long, filiform, not divaricate: spikelets very small and closely set along the ultimate branchlets; rhachis short woolly, but pedicel of flower little hairy. The specimen examined seems to be staminate, although the utricle is so largely developed as to possess papillate stigmatic branches so that there is no apparent reason why seed should not be produced, but the flowers seem to fall off after anthesis. Staminodia rather prominent, long and broad.

Guatemala, Volcan Tecroamburro, Santa Rosa, *Heyde & Lux* 4570. (1893).

+ + *Herbaceous or suffruticose.*

Iresine jaliscana, n. sp.

Herbaceous or suffruticose with green stems longitudinally ridged: leaves green, small, ovate-lanceolate, 3 to 8^{cm} long including petiole, appearing in fasciculate clusters at the nodes, these and the stem glabrous except on the very youngest growths: inflorescence a lax mostly leafless panicle with very slender branches, those of the second order long divaricate, bearing pedicelled spikelets mostly on one side; rachis of spikelets woolly, bracts acuminate, nearly as long as the sepals: sepals membranous, narrowly oblong; calyx slightly pedicellate with comparatively inconspicuous hairiness at base: in ♀ flowers the stamen cup is present bearing five imperfect stamens and very minute staminodia: utricle flat top-shaped, terminating above in a short style with two filiform stigmatic branches: ♂ plants not seen.

Mexico, state of Jalisco near Guadalajara, *Palmer* no. 92 (1886). Types in Columbia College, U. S., and John Donnell Smith herbaria.

* * * *Diœcious.*

+ *The whole plant (except older woody portions) densely white or gray tomentose.*

++ *Staminodia papillate, i. e., dissected into fine hair-like processes.*

IRESINE CANESCENS Humb. et Bonpl. in Willd. Sp. Pl. 4: 765.

Tromsdorfia canescens Mart. Nov. Gen. et Spec. Bras. 2: 42. 1826.

Distinguished by its sub-pyramidal very profuse paniculate inflorescence. The male flowers have prominent but abortive utricles showing even rudiments of stigmatic lobes: the staminodia are prominent and finely dissected into hair-like papillæ. In the female flowers the white woolly growth from the lower portion of calyx lobes and base of the flower is unusually conspicuous and dense.

Mexico, Lower California, Central America.

IRESINE CASSINÆFORMIS Schauer in Linnæa 19: 708. 1847.

Determined by Sereno Watson, who notes, "imperfectly agreeing with the description." It has the flower characters of *I. canescens* but differs in habit, being more woody, with narrower thicker leaves which are white tomentose beneath: the branches of female inflorescence are condensed into narrow panicles much less profuse than in typical *I. canescens*, of which it is possibly only a form.

Mexico, Monterey, *Palmer* 1133 (1880).

IRESINE SCHAFFNERI Wats. Proc. Amer. Acad. **21**: 437. 1886.

Suffrutescent: panicles mostly long pedunculate, the spikelets sessile and somewhat crowded upon the short branches: female flowers as in *I. canescens*: male flowers more pubescent on the sepals and longer bracted. The long pedunculate panicles seem to distinguish this plant from the two preceding.

Mexico. Types in Gray, J. D. S. and Columbia College herbaria.

++ ++ *Staminodia entire.*

IRESINE PRINGLEI Wats. Proc. Amer. Acad. **25**: 161. 1890.

Shrubby, finely tomentose, the very young leaves densely white tomentose, becoming bright green and nearly glabrous above and thinly tomentose beneath, lanceolate: sepals of female flowers rigid, 1^{mm} long, acuminate, spreading tips, a prominent bright green mid-nerve and white margins, very woolly, especially near the base. The species is well marked by the peculiar calyx of the female flower.

Reported from several states in northern Mexico. Types in Gray, J. D. S., and Columbia College herbaria.

IRESINE LATIFOLIA Benth. & Hook. Gen. Pl. **3**: 42. 1883.

Alternanthera latifolia Moq. l. c. 351. 1849.
Gomphrena latifolia Mart. & Gal. Bull. Acad. Brux. (Reprint p. 9). 1843.

Iresine laxa Wats. Proc. Amer. Acad. **21**: 454. 1886.

Suffruticose or woody, tomentose, leaves from broadly ovate to ovate-lanceolate, those on the flowering branches narrower and reduced: panicle more diffuse than in *I. canescens*, with flowering branches slenderer and more lax: flowers aggregated in spikelets, alternate and pedunculate along the opposite branchlets of the diffuse panicle: sepals of male flowers short hairy: staminodia long and narrow, not papillate: sepals of female flowers thin, densely long woolly. Those specimens described as *I. laxa* by Watson are like certain specimens which he called *I. latifolia*, agreeing also with those sheets from other herbaria labelled *I. latifolia*, which leads us to believe there is no distinction of species here.

Mexico, Lower California.

++ *Plants mostly glabrous.*

IRESINE INTERRUPTA Benth. Bot. Voy. "Sulphur" 156. 1844.

Alternanthera Richardii Moq. l. c. 353. 1849.

Suffruticose, erect, glabrous: leaves bright green and also glabrous: primary branches of inflorescence opposite and widely divaricate; secondary alternate, loosely set with spikelets of small unisexual flowers, the rachis and base of the flowers pilose: staminodia broad, dentate at summit.

Mexico.

IRESINE PANICULATA (L.) Kuntze Rev. Gen. Pl. 454. 1891.

Iresine celosioides L. Sp. Pl. 1456. 1762.

Mostly glabrous erect annuals or perennials according to habitat, those of the southwestern desert regions with stronger tendency to the latter: stem nerved or angled, often swollen at the joints; plant diffusely branching, often with small undeveloped branchlets in the axils of leaves: leaves petioled, tapering at both ends, ovate to lance-linear: inflorescence paniculate, always with reduced green leaves subtending the larger branches; spikelets oblong or linear, seldom pedicellate and never properly glomerate: in the male flowers there are mostly five stamens (sometimes only three?): staminodia if present very minute: usually no rudimentary ovary: sepals of female flowers 3-nerved, woolly: stamen cup exceedingly rudimentary, with five lobes indicating rudimentary stamens by their position: no ☿ flowers: polygamous plants have not been seen. The most clearly marked diœcious species of the Iresines.

Widely distributed over the southern half of the United States from Atlantic coast to New Mexico and south. Not reported north of Kentucky, Arkansas and southern Kansas.

IRESINE PANICULATA, var. **Floridana,** n. var.

Diffusely branching from a woody base, branches ascending and equal: roots long and fleshy: nodes crowded, less than

3^{cm} apart: leaves small and crowded: pistillate flowers clothed with long, straight, white wool.

Anastasia Island, Fla., Miss Mary C. Reynolds, 1875.

Labeled *I. diffusa* in J. D. S. herb. and *I. flavescens* in Columbia Coll. herb. Types in above herbaria.

IRESINE PANICULATA, var. OBTUSIFOLIA Coulter Bot. West. Tex. 364. 1894.

Lower leaves smaller, ovate or broadly spatulate, obtuse, more scabrous, especially beneath on the prominent white veins: panicle narrower, more leafy.

The species shades gradually into this variety, which however may stand as the type of a departure from the normal quite general among the southwestern forms.

Western Texas to Chihuahua.

Since *Iresine paniculata* is so widely distributed, it is naturally found to vary considerably in specific characters, so much so that without a large number of specimens for comparison one would be inclined to choose out certain forms for specific distinction. But with the large amount of material from various regions at our disposal there seems abundant reason to say that the following forms are to be included in the synonomy of *I. paniculata.*

Iresine flavescens Humb. et Bonpl. ex Willd. Sp. Pl. **4:** 766.

Alternanthera flavescens Moq. l. c. 350. 1849.—Those plants called *A. flavescens* Moq. by Chapman, and others so labeled (probably on the strength of Chapman's determinations) may be referred to *I. paniculata.* It is not certain that Chapman's type is identical with the original, but it accords well with the descriptions.

Iresine diffusa Humb. et Bonpl. l. c. **4:** 765.—Nuttall's plant which Moquin has cited under *I. diffusa* is identical with our specimens called *I. flavescens.*

Iresine gracilis Mart. and Gal. Bull. Acad. Brux. **10:** 347. 1843.—Here again all the specimens examined may be referred to *I. paniculata.* We are bound to say however that while we feel warranted in the present disposition of these species, we lack the important evidence of an examination of the types. These are not in American herbaria.

DICRAURUS Hooker f. Benth. et Hook. Gen. Pl. **3:** 42. 1883.

Apparently differing from the shrubby Iresines only by its alternate leaves. Not completely diœcious as previously described, for some plants have ☿ flowers. Staminodia present in all the flowers, papillate.

In this genus, as in Iresine, there are characteristic male and female inflorescences differing obviously from each other. Occasionally in both genera one finds a plant in which the characteristic male flower has a functional utricle, but more often the female flower is found producing functional stamens. In one of the Dicraurus specimens (Nealley, Chenates region Western Texas [1889] Coulter herb.), although the plant is evidently of the female type, all the flowers have from two to five pollen-bearing stamens.

DICRAURUS LEPTOCLADUS Hook. f., l. c.

Leaves very small, ovate or ovate-lanceolate, 12–25^{mm} long. Flowering branches rather long and stout, with compact inflorescence. *I. alternifolia* var. *Texana* Coulter. Referred to above as having ☿ flowers.

Western Texas and Mexico.

DICRAURUS ALTERNIFOLIA (Wats.).

Iresine alternifolia Wats. Proc. Am. Acad. **24**: 72. 1889.

Leaves larger, ovate or oblong, truncate or cuneate at base, occurring in fascicles which subtend the flowering branches, these being short, slender and divaricate, much branched: flowers smaller than in the preceding, the female with more conspicuous woolliness.

Mexico, Guaymas, *Palmer* 276 (1887).

In concluding the synopsis of North American Amaranthaceæ we append a brief account of two genera which were not included in order, earlier in the revision; namely, *Celosia* and *Acanthochiton*.

CELOSIA L. Gen. Pl. no. 289. 1737.

Distinguished from our other genera by its two to several seeded utricle.

CELOSIA PANICULATA L. Sp. Pl. 206. 1753.

Our most common species. Florida, Southern Texas, Mexico.

CELOSIA PALMERI Wats. Proc. Amer. Acad. **18:** 143. 1883.

Differing from *C. paniculata* in foliage, inflorescence and broader and less acuminate bracts and sepals.

North Mexico.

CELOSIA FLORIBUNDA Gray Proc. Amer. Acad. **5:** 167. 1861.

Very distinct in foliage and its abundant compact inflorescence.

Lower California.

ACANTHOCHITON Torr. Bot. Sitgr. Rep. 170. *pl. 13.* 1893.

A monotypic genus between *Amaranthus* and *Acnida.* Diœcious; distinguished by the remarkable bract development in the ♀ flowers.

ACANTHOCHITON WRIGHTII Torrey. l. c.; also in Bot. Mex. Bound. 179. 1859.

Texas.

Herbarium Lake Forest University.

A study of some anatomical characters of North American Gramineæ. VI.

THEO. HOLM.

WITH PLATES XXVII AND XXVIII.

Oryza sativa L.

The leaf of this grass shows a very great resemblance to that of *Leersia oryzoides* Swtz. which we have described in a previous article upon the leaf-structure of the genus Leersia.[1] The leaf of Oryza (fig. 1) shows the large development of the median part, containing not only a mass of colorless parenchyma, but also several mestome bundles on the superior face of the blade. But it differs by the presence of the large lacunes, the larger number of mestome bundles on both faces of the keel, and the absence of bulliform cells on the inferior face of the blade. We remember that in Leersia there was one group of bulliform cells developed on each side of the keel on the superior and the inferior face.

Considered by itself, the leaf of *Oryza* may be characterized as follows: The epidermis, seen *en face*, represents two forms, viz.: strata of short broad cells with undulated radial walls which cover the mesophyll and in which the stomata are to be observed, and strata of long and very narrow cells which cover the stereome. A transverse section of these strata (fig. 5) shows the narrow lumen of the last mentioned form, that which lies outside the stereome in contrast to the other one, outside the mesophyll. The bulliform cells (fig. 4) occur only on the superior face between the mestome bundles, and none are to be observed above the keel. Epidermal expansions are numerous, as roundish warts or as curved thorn-shaped bodies; the last are confined, however, to the strata outside the stereome. The stomata seemed to be equally distributed on both faces of the leaf-blade, but as stated above, they occur only in the strata outside the mesophyll, excepting where the bulliform cells are situated.

The mestome bundles are very variable in size, a fact which

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[1] BOT. GAZETTE **17**: 358–362. N 1892.

is especially noticeable when we examine the median part of the leaf (fig. 1). There are two midribs, one above the other, of which that nearest the inferior face is the largest (*a*, fig. 1). Besides these the section contains eight other ribs, of which those of the superior face are the smallest. We have, however, examined leaves of other specimens in which the median part of the blade contained no less than twenty-four mestome bundles, two of which were imbedded in the colorless parenchyma.

Turning to the lateral parts of the blade (fig. 2), we observe a similar difference in the development of the mestome bundles and by comparing them with those of the keel, we may distinguish four different degrees of development. The midrib of the inferior face represents the largest mestome bundle. It is surrounded by colorless parenchyma, of which the inner layer forms a sheath all around the bundle, bordering on a thick-walled and perfectly closed mestome sheath. The leptome and the hadrome are well differentiated and separated from each other by a small layer of thick walled mestome parenchyma. This mestome bundle is not in connection with any layer of stereome. There is, however, a large group of this tissue developed in the keel itself, but this is, as shown in figure 1, separated from the mestome bundle by the colorless parenchyma.

The mestome bundles of second degree (*b*, fig. 1) are represented not only in the median but also in the lateral parts of the blade. They differ from the above described merely in their smaller size and by the fact that the parenchyma sheath is here interrupted by the stereome on the inferior face of the bundle. The superior face, on the contrary, shows a group of colorless parenchyma, which is very large in the keel, but much smaller in the lateral parts of the blade. The mestome bundles of third degree (*c*, fig. 1) are very small and contain very little hadrome and leptome; they have no thick walled mestome parenchyma. The parenchyma and mestome sheaths are, however, well developed, the first being interrupted by the adjoining group of stereome. As mentioned above, some of the leaves we have examined were much larger than those in question, and we have observed some bundles to be imbedded in the colorless parenchyma of the keel. One of these bundles is shown in fig. 10, and this represents the fourth degree of development. It has no distinctly differentiated parenchyma sheath, while the mestome sheath is very well developed, perfectly closed, and thick walled as in all the other mestome bundles. There is only one vessel in this bundle and a small group of leptome. These small bundles were observed only in the keel, in the parenchymatic layers which connect the two surfaces of the keel with each other, bordering on the large lacunes (*L*, fig. 1).

In regard to the general distribution of these various forms of mestome bundles in the leaf-blade of Oryza, those of the third degree are the most numerous, while those of second degree are less so; these last constitute the very rough ribs, which are so prominent on the upper surface of the leaf.

The stereome has attained a large development in this grass, and forms layers above and below all the mestome bundles of the lateral parts of the blade; as we have seen in figure 1, there is no stereome on the inner side of those mestome bundles which are situated in the keel. The margins of the blade possess large isolated groups of this tissue.

The mesophyll shows very distinctly that form of cells which Haberlandt[2] has designated as "Armpallisadenzellen" (fig. 3), in which the cell wall shows deep foldings inwards. This form of tissue has been observed in representatives of widely separated families of the vascular plants, e. g. Anemone and several other Ranunculaceæ, Bambusa, Arundinaria and a few other Gramineæ, Sambucus, several Gymnospermæ, Filices, Equisetum, etc. Haberlandt has explained the physiological signification of this peculiar folding of the cell wall in this way, that thereby the inner surface of the cell becomes considerably enlarged so as to be able to give space for an increased number of chlorophyll-grains.

The mesophyll in Oryza forms isolated groups between the mestome bundles, and surrounds the large lacunes of the keel.

The colorless parenchyma is very well represented as we have already seen above from the description of the mestome bundles and their surroundings. We have discussed the colorless parenchyma sheath, the various groups of the same kind of tissue above the mestome bundles, and finally the large layers which divide the lacunes of the keel. A marked characteristic of Oryza is the structure of the keel, with its

[2]G. Haberlandt: Physiologisches Pflanzenanatomie 174. Leipzig 1884.

numerous mestome bundles and large lacunes in which diaphragms are to be found (as shown in fig. 7), somewhat resembling those which characterize various species of Juncus.

Washington, D. C.

Explanation of Plates XXVII and XXVIII.

Figs. 1–10. Transverse sections of the leaf-blade of *Oryza sativa.*

Fig. 1. The median part, showing five mestome bundles on each face, those of the inferior face being the largest. The lacunes (*L*) are separated by narrow strata of colorless parenchyma. The mestome bundles *a*, *b*, *c*, represent respectively first, second and third degree of development. × 75.

Fig. 2. The lateral part of the blade; *J*, the inferior face; *S*, the superior. × 75.

Fig. 3. Chlorophyll-bearing cells of the mesophyll; the cell-wall showing deep foldings inward; *P*, cells of the parenchyma-sheath; *BC*, bulliform cells. × 320.

Fig. 4. Group of bulliform cells. × 320.

Fig. 5. Epidermis of the inferior face, *Ep*, with a part of a mestome bundle. × 320.

Fig. 6. Epidermis of the superior face, *Ep*, bordering on a group of stereome, *St*, and colorless parenchyma, *P*. × 320.

Fig. 7. Cells of a diaphragm from the lacunes. × 320.

Fig. 8. Part of the large dorsal mestome bundle from the keel. *Ep*, epidermis; *St*, stereome; *P*, colorless parenchyma; *MS*, mestome-sheath; *Lpt*, leptome; *V*, vessels. × 320.

Fig. 9. The median mestome bundle of the superior face of the blade. × 320.

Fig. 10. A very small mestome bundle, representing the fourth degree of development, from the colorless parenchyma of the keel. × 340.

A synopsis of the American species of Ctenium.

JARED G. SMITH.

WITH PLATE XXIX.

Artificial key to the species.

1. Spikes 1 or 2 2
1. Spikes 3 to 6, awns of the third and fourth glumes three times as long as the glumes themselves . . . . . . *C. polystachyum.*
2. Awn of the fourth glume nearly 2 inches, recurved. *C. cirrhosum.*
2. Awn of the fourth glume less than 1 inch, straight or simply divergent 3
3. Nerves of the second glume strongly tuberculate-roughened . 4
3. Nerves simply scabrous . . . . *C. Chapadense.*
4. Awn of the fourth glume twice exceeding it 5
4. Awn about equaling or shorter than the fourth glume . . . 6
5. Fifth glume twice as long as its awn; spike 4 to 5 inches . . . . *C. planifolium.*
5. Fifth glume equaling its awn; spikes 2 inches . *C. glandulosum.*
6. Awn of the fourth glume about equaling the glume itself . . 7
6. Awn of the fourth glume less than half as long as the glume itself . . . . *C. brachystachyum.*
7. Spike 1½ inch long, awns slender . . . . . *C. brevispicatum.*
7. Spike 2½ to 5 inches long, awns stout . . . *C. Carolinianum.*

1. *Spikes three to six.*

CTENIUM POLYSTACHYUM Balansa Bull. Soc. Bot. de France 32: 244. 1885.

Culms cespitose, two to four feet high; leaves pubescent; spikes three to six, digitate-paniculate; spikelets 4-flowered; third and fourth glumes 3-nerved, long-ciliate on the lateral nerves, the middle nerve prolonged into a scabrous awn three or more times the length of the glume; fifth glume keeled, ciliate only along the margin, 3-nerved.

Paraguay.

2. *Spikes one or two; awn of the fourth glume nearly two inches, recurved.*

CTENIUM CIRRHOSUM Kth. Rev. Gram. 445. *pl. 136.*
Campulosus cirrhosus Nees Agrost. Bras. 416.

Culms slender, cespitose, two to four feet high; leaves scabrous; spike one; first empty glume nearly as long as the spikelet; second empty glume much exceeding it; third glume with an awn twice as long as itself; fourth glume with a recurved awn nearly two inches long; fifth glume cuspidate or mucronate at the apex.

On high plains in southern Brazil.

3. *Spikes one or two; awn of the fourth glume one-half inch long or less.*

a. *Nerves of the second glume scabrous, not glandular-tuberculate.*

CTENIUM CHAPADENSE Doell. in Mart. Flor. Bras. 2[3]: 73.
Campulosus Chapadensis Trin. Sp. Gram. *pl. 303.*

Culms slender, three feet high, basal leaves six to nine inches, those of the culm about four inches long, the uppermost shorter; spike one, terminal; first glume a little shorter than the spikelet; second glume twice exceeding it; third and fourth glumes ciliate, pilose at the base, with awns four or five times longer than themselves; fifth glume ciliate, naked at the base, longer than the third and fourth glume, with an awn a little longer than itself.

Florida to Argentina.

b. *Nerves of the second glume strongly glandular-tuberculate.*

Ctenium glandulosum Scribn. & Smith, sp. nov.—*Plate XXIX.*

Culmi 14–18 pollices longi, simplices, erecti, teretes, striati, scabri praesertim sub nodis, apice distincte striati pubescentes cum annulo hirsuto basi inflorescentiæ, nodis glabris; vaginæ striatæ internodis breviores; laminæ planæ, striatæ, glabræ, aut supra minute scabræ, lineares, 4–12 pollices longæ, 1–1.5 lineas latæ, apicem versus filiformes, summæ breviores, involutæ, setaceæ; spica unica pectinata, saepe 2 pollices longa, recta aut falcata subspiralis, rachis plana scabra; spiculæ patulæ biseriatæ dense imbricatæ; gluma vacua prima obliqua linealis, basi tuberculato-crassa, 1-nervis, acuta interdum dentata; gluma vacua secunda 3 lineas longa, obliqua, lanceolata, trinervis, nervo medio in aristam scabram excurrente ex quarta basali glumæ, pulvino in axilla aristæ prominente, arista glumæ subaequali, nervis lateralibus glanduloso-tuberculatis per inferiorem bessem, scabris superne; gluma tertia vacua lanceolata acuta, sesquilinealis, arista duplo longiore, tenui, scabra, excurrente ex tertia summa glumæ, trinervis, marginibus albis ciliis cristatis basi dense barbata; gluma quarta cum palea neutra duas lineas excedens, lanceolata acuta, trinervata, marginibus medio pilis albis cristatis, semilinealis, arista dorso 4 lineas longa sub apice oriente; gluma quinta florens, duas lineas longa, arista 3 lineas longa, palea subaequilonga, apice bidentata 2-nervis, ciliatis; gluma sexta sterilis, glabra, brevipedicellata subapice mucronata sesquilinealis; gluma septima rudimentum, linearis, semilinealis, pedicella tenuissima.

This species is founded on no. 2814 Nelson, collected between Niltepec and Zanatepec, Oaxaca, July 15, 1895, at an altitude of 400 feet. It has the habit of the Brazilian *C. brevispicatum* nom. nov., but the details of the spikelets do not agree.

Ctenium brevispicatum, nom. nov.

Campulosus brachystachyus Trin. Sp. Gram. *pl. 302,* not Nees.

Culms cespitose, one to two feet high, distinctly pubescent above, glabrous at the nodes; leaves about a foot long, smooth and glabrous except on the slightly hispid margins; spikes one or two, digitate, from one and one-half to two inches long or longer; first empty glume one-fourth the length of the spikelet; second empty glume as long as the spikelet; third and fourth glumes pilose at the base and along the margins above, awned from below the apex, the awns about equaling the glumes; fifth glume densely villous on the margins above, the awn usually a little shorter than the glume.

Brazil.

Ctenium brachystachyum Kth. Rev. Gram. 447. *pl. 137.*

Campulosus brachystachyus Nees Agrost. Bras. 417, not Trin. Spec. Gram. *pl. 302.*

Culms cespitose, very slender, glabrous, one and one-fourth to two feet high; culm leaves rigid, scabrous on both sides, four to five inches long; spike terminal, one and one-fourth to one and one half inch long; spikelets 5-flowered; first empty glume very much shorter than the spikelet; the second nearly equaling it, third and fourth glumes densely clothed along the margins with long, strict, white hairs, scabrous towards the apex, the awns one-half as long as the glumes; fifth glume emarginate at the apex and mucronate-awned, clothed with long strict white hairs at the margin, its awn very short straight and scabrous.

Brazil.

CTENIUM PLANIFOLIUM Kth. Enum. Pl. **1**: 275.

Campulosus planifolius Presl. Rel. Haenk. 287.

Culms two to two and one-half feet high, scabrous, especially below the nodes; leaves scabrous on both sides; spike one, more than four inches long; first empty glume very much shorter than the spikelet; second empty glume nearly equaling the spikelet, 2-nerved, hirsute; third and fourth glumes pilose on the back and margins, the third with a straight awn as long as itself; the fourth with an awn twice as long as itself; fifth glume a little longer than the lower ones, hirsute on the back, the margins densely white-pilose, terminated with a straight scabrous awn half as long as itself.

Mexico.

CTENIUM CAROLINIANUM Panz. in Denkschr. Akad. Muench. **1813**: 311. 1814.

Ctenium Americanum Spreng. Syst. **1**: 274. 1825.

Aegilops aromatica Walt. Flor. Car. 249.

Campulosus aromaticus Scribn. Mem. Torr. Bot. Club **5**: 45.

Culms one and one-half to four and one-half feet high; leaves six to fourteen inches long, glabrous; spikes one or two, one and one-half to six inches long; first empty glume one-third as long as the second, which is about as long as the spikelet; third glume pilose at the base and along the margins, awned below the apex with a stout spreading awn shorter than the glume; fourth glume one-third longer than the third glume, pilose at the base and tufted-ciliate on the margin about the middle, awned below the bifid apex with a stout divergent awn about as long as the glume; fifth glume about as long as the fourth, similar to it, except for the much shorter and less spreading awn.

North Carolina along the coast to Alabama.

Department of Agriculture, Washington, D. C.

EXPLANATION OF PLATE XXIX.

Ctenium glandulosum Scribn. & Smith.—*a, e, e,* empty glumes.—*b,* florets: b^1, third glume; b^2, fourth glume; b^3, fifth glume.—*d.* Fifth glume and palea.—*c.* Sterile rudiments.

The rate and mode of growth of banana leaves.

WALTER MAXWELL.

The quick rate of growth of young banana trees is a matter of general observation. This unusual growth is, in itself, a subject of interest; and when viewed in comparison with the development of the sugar cane and other plants, and in the light of the general laws and conditions of vegetable growth, this great rapidity of development, by which it unfolds leaf after leaf, makes the banana a very conspicuous example, and it has led me to record data showing the daily increase in the length and substance of growing leaves.

The following observations were made upon banana trees growing in front of my veranda, which were planted in December. The data may appear to cover a large surface of paper; they were recorded, however, during the spare minutes around meal times, and may properly be called *a door step study.*

In the two first examples noted the young leaf was observed just as it emerged from its enclosure within the stem of the previously grown leaf, which mode of development it is instructive to watch. When fairly started, the length of the leaf was taken, and the measurement was repeated, at a given time, on each succeeding day, until the leaf was unfolded and full-grown.

The two following tables give the history of two leaves whose development was observed in the way explained. Observations were made upon no. 1 at 1 P. M., and upon no. 2 at 5:30 P. M. In all tables lengths are given in inches and temperatures in degrees Fahrenheit.

Leaf I.

Date.		Length of Leaf.	Daily Growth.	Mean Temp.	Wind.
Jan.	26	6.5	0.0	70.5	N. E.
	27	9.5	3.0	71.5	N. E.-S.
	28	14.5	5.0	74.0	S.
	29	20.5	6.0	76.5	S.
	30	25.25	4.75	70.0	N.-N. E.
	31	29.5	4.25	71.0	N.-N. E.
Feb.	1	35.0	5.5	73.0	N. E.
	2	36.0	1.0	73.5	E.-N. E.

Leaf II.

Date.	Length of Leaf.	Daily Growth.	Mean Temp.	Wind.
Feb. 1	6.0	0.0	73.0	N. E.
2	9.75	3.75	73.5	E.-N. E.
3	13.5	3.75	74.0	N. E.
4	18.5	5.0	73.0	"
5	25.25	6.75	72.5	"
6	32.0	6.75	71.0	"
7	38.0	6.0	71.0	"
8	41.0	3.0	70.5	"
9	41.5	.5	68.5	"

The same observations were continued during the development of two more leaves, but with these examples the measurements were recorded twice daily for the purpose of noting the relative proportions of the day and night growths. The divisions of time were from 7:30 A. M. to 5:30 P. M., giving a period of day growth of ten hours; and from 5:30 P. M. to 7:30 A. M., giving a night period of fourteen hours. The day period represents approximately the hours that the sun was above the horizon.

Leaf III.—Night.

Date.	Length of Leaf.	Night Growth.	Night Temp.	Wind.
Feb. 9	0.0	0.0	65	N. E.
10	5.75	.75	64	"
11	8.75	1.25	66	"
12	13.25	1.25	62	N.-N. E.
13	16.5	1.0	60	"
14	22.25	2.0	65	S.
15	28.0	1.5	61	S. E.
16	35.5	3.0	62	N. W.
17	41.5	1.0	62	W.-S. W.
18	45.25	.75	62	S.
19	47.0	.5	63	S. W.

Leaf III.—Day.

Date.	Length of Leaf.	Day Growth.	Day Temp.	Total Daily Growth.	Wind.
Feb. 9	5.0	0.0	76	0.0	N. E.
10	7.5	1.75	73	2.5	"
11	12.0	3.25	75	4.5	"
12	15.5	2.25	75	3.5	N.-N. E.
13	20.25	3.75	76	4.75	"
14	26.5	4.25	78	6.25	S.
15	32.5	4.5	76	6.0	S. E.
16	40.5	5.0	77	8.0	N. W.
17	44.5	3.0	78	4.0	W.-S. W.
18	46.5	1.25	79	2.0	S.
19	48.0	1.0	78	1.5	S. W.

Leaf IV.—Night.

Date.	Length of Leaf.	Night Growth.	Night Temp.	Wind.
Feb. 26	5.5	0.0	67	E.-N. E.
27	8.5	.75	72	S. W.
28	10.75	.75	71	E.-N. E.
29	13.5	1.0	67	S. W.
Mar. 1	16.5	1.25	67	S.
2	19.25	.75	65	S. W.
3	23.25	1.25	64	E.-W.
4	28.0	2.0	61	W.-S. W.
5	36.5	2.75	62	W.-S. W.
6	44.75	1.25	64	N.
7	48:5	.75	65	N. E.
8	50.5	.5	65	N. E.
9	52.75	.25	66	N. E.

Leaf IV.—Day.

Date.		Length of Leaf.	Day Growth.	Day Temp.	Total Daily Growth.	Wind.
Feb.	26	7.75	2.25	78	0.0	E.-N. E.
	27	10.0	1.5	78	2.25	S. W.
	28	12.5	1.75	80	2.5	E.-N. E.
	29	15.25	1.75	80	2.75	S. W.
Mar.	1	18.5	2.0	81	3.75	S.
	2	22.0	2.75	77	3.5	S. W.
	3	26.0	2.75	72	4.0	E.-W.
	4	33.75	5.75	78	7.75	W.-S. W.
	5	42.0	5.5	80	8.25	W.-S. W.
	6	47.75	3.5	77	5.75	N.
	7	50.0	1.5	76	2.25	N. E.
	8	52.5	2.0	77	2.5	N. E.
	9	53.25	.5	76	.75	N. E.

Before speaking in detail of the data presented by the four tables giving the history of each leaf, for convenience, we shall bring these data together in a table of averages, in which are given the length, breadth, and surface development of the leaves, with the more detailed data. The "length of leaf" given is the total length of the mature leaf, less its length at the time of the first measurement. This correction is necessary, or the total "surface of the mature leaf," and the "daily surface growth" would be given too high.

The averages are as follows:

No. of Leaf.	Length of Leaf.	Breadth of Leaf.	Surface of Leaf. Sq. in.	Mean Growth of Day Period.	Mean Growth of Night Period.	Mean Daily Growth.	Mean Daily Surface Growth. Sq. in.	Mean Temp. of Growth.
No. I.	29.5	14	413	...	...	4.25	59.0	72.5
II.	35.5	14	497	...	...	4.5	62.0	72.0
III.	43.0	15	645	3.0	1.33	4.33	64.5	70.0
IV.	47.5	17	803	2.6	1.2	3.8	66.9	71.7

The first thing to which attention is called in this table is the mode of development. In the first place, a striking uniformity of growth is noted, and at the same time a gradual increase in the tree's capacity of assimilation, which is shown by the gradual increase in the "mean daily surface growth" from leaf I up to IV. I will state that these observations were made on one banana tree only, in order to exclude individual errors arising from the differences in individual trees, and that the four leaves were developed one after the other. This statement enables me to explain that the gradual increase in the daily surface growth from I to IV is due to the increasing area of assimilating surface. Each succeeding leaf has the last additional one to assist in gathering food for its growth, and the work goes more rapidly.

The increase in the rate of assimilation with the addition of new leaves is less than I expected to find. It is not in any way proportional to the increase of leaf surface; and this suggests that the chief burden in the work of making the next new leaf lies upon the previous leaf that was made. This is also further suggested by the banana tree's mode of growth. The banana appears to have only one center of growth and elaboration; it makes only one leaf at a time, and practically completes one leaf before it begins with the next. Many other trees are producing scores of leaves at the same time, showing that centers of work are distributed over the tree's complete organism. Moreover, the full grown leaves of the banana are soon frayed out with the wind and rendered useless for work, which forces the work of assimilation upon the new leaves. The details in the tables also show strikingly the variation in the rate of growth along the period of development. The young leaf begins slowly, daily increasing its rate of increase up to the stage of its maximum power of growth, where it tarries for two or more days, until the leaf, which hitherto has been almost as tightly rolled up as a cigar, begins to unfold to the light, when the rate of growth falls off till it is full grown. In the history of the four leaves this mode of growth is seen to obtain.

One other striking truth set forth by the daily data of development is the difference between the growths of the "day" and "night" periods. The observations were continued upon leaves III and IV not only to compare the results of the day and night growths, but also to note the results of variations of temperature. The mean night growth of leaves III and IV was 1.25 inch, and the mean daily growth was 2.8 inch, which shows that about 70 per cent. of the total growth took place during the day, between 7:30 A. M. and 5:30 P. M. It also illustrates the effect of length of day.

The effect produced by variations of either day or night temperatures it is not easy to decide. In leaf I, for example, it is strongly indicated that the sudden and great fall of temperature on Jan. 30th, continuing over Jan. 31st, caused a decrease in the growth of the leaf. In the other examples, such as IV, a small fall in the night temperature, as on March 4th, does not at all interfere with the maximum growth. From this it appears that a great lowering of the temperature is necessary to seriously arrest progressive growth.

I am of opinion that the action of direct sunlight, and the direction and force of the wind, are more potent factors in increasing or arresting growth than small variations of temperature. On this subject I have, at present, no conclusive data.

The banana is an excellent subject in which to study given features of physiological development. The growth of its leaves is so rapid that measurements can be recorded twice daily with a measuring rule, and with the possibility of extremely small error. This is of great value in affording light upon the laws and conditions affecting the growth of other plants. The sugar cane, for example, grows so comparatively slowly that with it such observations as I have recorded are not possible. It will probably not be far wrong, however, if the data obtained in observing the banana are applied in judging of the influences which affect the growth of cane and other plants.

Hawaiian Experiment Station, Honolulu, H. I.

Noteworthy anatomical and physiological researches.

Researches on Drosophyllum lusitanicum.

A contribution on the vexed question of the nutrition of insectivorous plants is made by A. Dewèvre.[1] He has endeavored to ascertain whether the insects caught are really digested by a secretion from the plant as contended by Hooker, Darwin, Penzig and Goebel or whether bacteria digest them, the plant merely absorbing the products formed, according to the views of R. Dubois and Tischutkin.

After an anatomical and physiological investigation of the plant, the author concludes in spite of a number of negative results that absorption of proteids does take place; the absorption of carbohydrates is doubtful. Concerning the method of absorption the author ventures no statements.

The stem of Drosophyllum is very well developed, and the plant is perfectly well able to dispense with the nitrogen supply furnished by its captures. Moreover, the anatomical structure of the glands, both of the sessile and of the pedicellate types found, is not in harmony with the function of absorption. Since the supply of albuminous substances at the lower surface of the leaf would be more detrimental than beneficial, the author is inclined to question any connection whatever between the nutritive function and the mucilaginous, peptone-containing secretion formed by the glands in question.

When the inability to prove the absorption of the mucilaginous substance is taken into account, it is necessary to ascribe to this secretion another rôle. The author regards it as protective. By reason of its viscosity, this mucilage holds the insects that come in contact with it, kills them in a short time, then by the action of the pepsin which it contains, dissolves them and thus frees the leaf of them. In connection with the lower organisms, this protective function is still more marked. The entrance of bacteria and of spores of fungi into the interior tissues of this plant would result in serious consequences. The glands and their secretions prevent this since spores of fungi were found not to grow in this mucilage.—RODNEY H. TRUE.

[1] Annales des Sci. Nat. Bot. VIII. **2:** 19. 1896.

The root-hairs of Coniferæ.

Dr. C. von Tubeuf closes a series of papers entitled, "Die Haarbildungen der Coniferen" in *Forstlich-naturwissenschaftliche Zeitschrift* with an account of the root-hairs of the Coniferæ,[1] of which the following is an abstract.

Of the root-hairs of Coniferæ little is known. In the few instances in which they have been observed they have been considered functionless. Schwarz found among all the species of Pinus and Abies observed, only Abies obovata sometimes with very short hairs which could scarcely be of any importance in absorbing water.

Strasburger states[2] that root-hairs are entirely wanting in species of Thuja, Sequoia, and Araucaria; are present exceptionally in Ephedra, sparingly in Pinus spp., and abundantly only in Taxus.

But von Tubeuf finds twenty-four species capable at least of producing root-hairs, and though no root-hairs were found on seven species he thinks it not certain that these species do not, at other times or under other conditions, form root-hairs.

On firs (Picea excelsa) three to six years old, few or no hairs were found between Feb. 28th and May 28th, but by June 28th the many young rootlets were clothed with many hairs which were present up to Nov. 28th.

The shape of the hairs is very various. In the Abietineæ they are always very long filaments and arise at a considerable distance from the tip of the root and from the second or third layer of the cortex, breaking through the outer cells, which slough off. Among the Taxaceæ, only Ginkgo has long thin-walled filamentous hairs. Taxus has very short rigid hairs whose walls are finely papillose. The hairs of Torreya and Cephalotaxus, having a very broad base, are mostly conical and very numerous, arising close behind the root tip.

The function of the root-hairs appears to be that of these structures elsewhere, viz.: to increase the surface by which water and food materials are absorbed. Frank combats the idea that they can suffice for this work and thinks that it is properly accomplished only when fungi (which he calls "Baumammen") invest the lateral roots as a mycorhiza. From

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[1] Forstl.-naturwiss. Zeits. **5:** 173–193. *pls. 3.* My 1896.
[2] Coniferen u. Gnetaceen 343.

his *Lehrbuch der Botanik* it is not apparent that the Coniferæ form any root-hairs but one is left to infer that they are supplied exclusively through the fungi. Indeed he says (op. cit. 259) that mycorhiza is a constant phenomenon in all forest trees of Cupuliferæ, Betulaceæ and Coniferæ; that this symbiosis has been found everywhere it has been sought, in all sorts of soils; that the fungus is present from the first year of the tree throughout its life upon all the absorbing roots; that the entire absence of root-hairs is a striking peculiarity of mycorhiza; and that the tree receives water and food materials only through the mycorhiza fungus. These statements are repeated essentially in his "Die Krankheiten der Pflanzen" (1895) and are much more radical than his earlier ones, in which he speaks of root-hairs of pines as normal in humus-free soils while mycorhiza generally appears in humus soils. In all his publications he recognizes only one form of mycorhiza which he calls the ectotrophic.

But Sarauw in 1893 had found intracellular mycelium in Cedrus and in Taxus. Von Tubeuf, also investigating numerous conifers in all situations, has discovered that an intracellular mycelium occurs very commonly among the living cells of the cortex in many species of certain families so that Frank's *endotrophic* mycorhiza has an unexpectedly wide distribution.

In all Abietineæ, and in this family alone, ectotrophic mycorhiza may occur either (a) as a purely external jacket, or (b) as a jacket sending hyphæ into the intercellular spaces of the cortex, or (c) as an intracellular mycelium only, with root-hairs. It was found that all Abietineæ are capable of producing root-hairs *at the same time.* Endotrophic mycorhiza occurs in very many conifers of other families, agreeing neither with Frank's ericaceous nor orchidaceous types, but constituting a coniferous type, characterized by having the mycelium in a deep-seated zone of the cortical cells, the outer ones being free from it, and without special connection with the outer hyphæ as is the case in ectotrophic mycorhiza. It does not affect the formation of root-hairs, which are often luxuriantly developed on mycorhizal roots. The abundance of the hairs suggests that they are functional and experiments demonstrated this. Plants were cultivated in sterilized soils with artificial fertilizers; they developed normally, produced abundant root-hairs and grew vigorously for two years.—R.

BRIEFER ARTICLES.

A remarkable macrospore.—In recent literature references to Treub's "*Casuarina*"[1] are becoming quite frequent, and deservedly so, for *Casuarina* is a remarkable plant and the monograph gives the results of extensive investigations. The account of chalazogamy alone would make the paper a classic, but the peculiarities in the embryo-sac seem to merit equal attention. Treub says that the embryo-sac of *Casuarina* contains a sex-apparatus normally composed of two or three cells which seem to be derived from a single mother cell, yet the author claims that the cells associated with the oosphere are not synergidæ, but have an entirely different origin. The assertion is also made that in *Casuarina* no antipodal cells are formed. The lack of a secondary nucleus formed by the fusion of two polar nuclei is another exceptional feature, while the formation of endosperm and also the formation of cell walls around the oosphere and other cells of the sex-apparatus before fertilization complete a list of striking variations from the normal angiosperm type.

I have been deeply interested in Casuarina's embryo-sac without antipodals, as I have been studying *Salix*, and for more than a year was unable to discover any trace of antipodals. However, *Salix* has antipodals, as some of my preparations now prove. Some slides also show the fusion of polar nuclei to form the endosperm nucleus. There is no doubt that the antipodals of *Salix* are exceedingly transitory but they are formed nevertheless. It may be that *Casuarina* has antipodals of this evanescent character. Since the technique betrayed by Treub's figures and text could be greatly improved, I should be glad to see the Casuarina sac studied again and in much greater detail, in order that Treub's conclusions may receive additional confirmation or be corrected.—CHAS. CHAMBERLAIN, *University of Chicago.*

Aster tardiflorus: a correction.—My attention has been called to a clerical error in my paper on *Aster tardiflorus* in the preceding number of the GAZETTE. On page 275, in the last clause of the first paragraph, the words "inner" and "outer" should be transposed; and the clause should read: the outer scales of the imbricated involucre longer than the inner. The error originally arose through mistaking the phrase "*inferioribus longioribus*" for *interioribus longioribus.*—MERRITT LYNDON FERNALD, *Cambridge, Mass.*

[1] Sur les Casuarinées et leur place dans le systeme naturel. Ann. Jard. Buit. **10:** —. —.

CURRENT LITERATURE.

Essentials of Botany.[1]

WHEN Professor Bessey began to publish his text-books the botanical instructors of the United States were teaching chiefly the gross morphology and classification of "flowering plants" as presented by Gray's fascinating text and manual. A larger view of plants had taken possession of Germany, and this view Professor Bessey sought to transplant. How well he succeeded is witnessed by the revolution that followed in American botanical teaching, especially in the colleges. The ready response, the adoption of real laboratory methods, the multiplication of texts and laboratory guides on the new basis, all show how great was the need. Among all the American books, however, which belong to the new dispensation, those of Professor Bessey fairly stand as the pioneers. His very large and successful experience as a teacher has peculiarly fitted him for the work, and has enabled him to organize the text and touch the needs in a way quite beyond the comprehension of the mere investigator.

It is with great pleasure that we welcome the new edition of his very useful "Essentials," for the rapid advance of the science had left the old one inadequate in many important particulars, which the author appreciated more keenly than any one. As the book has been and must continue to be one of the most largely used texts it is to the interest of botany for it to present current views. The most notable change is to be found in the new chapter on plant physiology, a subject which has been made a science since the old text was written. Protoplasm and the cell-structures are also freshly presented in the light of new knowledge. In the matter of classification, Professor Bessey has his own views, presented to the botanical public before, and now in his new book. His rejection of the slime-moulds as plants, and his similar but not so positive disposition of *Pandorina* and *Volvox*, may simplify classification, but probably will not satisfy botanists. The breaking up of Thallophyta into three great groups (Protophyta, Phycophyta and Carpophyta) coordinate with Bryophyta, etc., and the submergence of the well known categories Algæ and Fungi, is a view which will have to fight its way, but has undoubtedly the merit of easy presentation to beginners. We wish that

[1]BESSEY, CHARLES E.—The Essentials of Botany. Sixth Edition, revised and enlarged. 1896. New York: Henry Holt & Co.

Professor Bessey had abandoned the term "Anthophyta," as but little more appropriate than "Phanerogamia," and adopted the really significant term "Spermatophyta" (too often written "Spermaphyta"); and that his popular name "flowering plants" had been changed to "seed-plants."

In the presentation of the angiosperms Professor Bessey follows neither the grouping and sequence of Bentham and Hooker, nor of Engler and Prantl, but has formulated one of his own. That the presentation of Bentham and Hooker should be abandoned is clear; but those of Engler and Prantl, and of this book are based upon opposite propositions which the morphology of the future must settle. Bessey's proposition that "in the primitive flower all the parts were separate" coincides with the Engler position as far as it goes. But Bessey's "primitive flower" has some or all the parts in a cyclic arrangement, and then calls for the reduction process to produce the simpler flowers. Engler, on the contrary, sees in these simpler flowers not reduced forms but primitive forms; his primitive flowers having free parts, to be sure, but these parts spirally arranged and consequently indefinite in number, the cyclic arrangement and hence definite numbers appearing later. Whether the so-called "simpler flowers" are so because of reduction or because they are primitive is as yet largely a matter of opinion, and Professor Bessey has chosen the former alternative.

But such a discussion leads us far away from the purpose of the book before us, which is certainly an effective recasting of a long-tried and very useful text.

Citrous fruits.

MESSRS. W. T. SWINGLE AND H. J. WEBBER, of the Division of Vegetable Physiology and Pathology, Department of Agriculture, have been working for three years in the subtropical laboratory at Eustis, Florida, upon the diseases of citrous fruits. Bulletin no. 8 has just been issued from the Division, giving for the first time the results of their work upon the principal diseases. Six diseases are presented: blight, die-back or exanthema, scab or verrucosis, sooty mold, foot-rot or mal-di-gomma, and melanose. In each case the symptoms, cause, and treatment are described, illustrated by eight plates, three of them colored. While much of the Bulletin deserves reprinting and wide attention, the following outline from the summary may indicate a few of the results:

1. *Blight:* Attacks trees only when over five years old and in bearing, causing sudden wilting of the leaves; in the spring after the top

wilts the branches bloom profusely, but the flowers are small and almost never set fruit; the affected trees may linger for many years, and rarely die outright; the annual loss from this disease in Florida is about $150,000; the cause is unknown, but it is probably a contagious malady and incurable; affected trees should be dug up and burned.

2. *Die-back* or *exanthema:* Caused by malnutrition, accompanied by improper drainage, improper cultivation, etc.; recognized by the very large dark pointed leaves and the reddish-brown stains on certain of the new-growth twigs, which later die back; brown eruptions occur abundantly on young and old twigs, all of which finally die back; multiple buds form in the leaf axils; diseased trees bear little fruit, which is off color and commonly disfigured by the reddish-brown stain; annual loss from the disease in Florida about $100,000; withholding all organic nitrogenous manures, ceasing to cultivate, and mulching the soil have been found beneficial.

3. *Scab* or *verrucosis:* Attacks principally sour oranges and lemons, the common sweet orange being exempt; probably introduced into America from Japan; shows as small excrescences on young leaves and fruit, at first pale, but soon coated with a dusky growth of *Cladosporium*, the parasite causing the disease; very much distorts young leaves and the fruits; loss chiefly from action on lemons, causing an annual loss in Florida of about $50,000; prevented on lemons by spraying young fruits from three to five times with ammoniacal solution of copper carbonate.

4. *Sooty mold:* A black fungus, which follows the attacks of certain honeydew-secreting insects; recognized by the sooty black membrane formed principally over upper surfaces of leaves, fruits, and stems; greatly reduces productivity of trees, and the oranges formed are badly disfigured; annual loss in Florida from the disease about $50,000; spraying with resin wash has been found very effective, also fumigation with hydrocyanic acid gas; a parasite fungus (*Aschersonia tahitensis*) promises to be a very great aid in combating the malady.

5. *Foot rot* or *mal-di-gomma:* The most widespread of all orange diseases; recognized by exudation of gum from patches on the tree near the base, resulting in falling off of the bark; spreads down the roots and around the trunk, the tree often being girdled and killed; apparently contagious and caused by some minute organism; the sour orange almost exempt, and disease may be prevented by using sour orange stocks on lowlands and flat woods, and grape fruit stocks on high and dry pine lands; removing soil from around the crown roots the most effective treatment; annual loss from the disease in Florida about $100,000.

6. *Melanose:* A new disease, not yet causing much damage in Florida, probably only about $5,000 in 1894; forms minute brown spots on leaves, twigs, and fruits, greatly staining and disfiguring the fruit; cause not certainly known, but probably some parasitic fungus; very effective remedy is the application of Bordeaux mixture or ammoniacal solution of copper carbonate to the young fruits.

A manual on the food of plants.

Elementary guides to simple laboratory practice, constructed upon approved methods, are not yet numerous, and must be always welcome. In many respects the little pocket manual on the food of plants, prepared by A. P. Laurie,[1] is a model. It is arranged in a strictly logical sequence, is inductive in method, and brings the subject within the apprehension of the beginner. The aim of the work is to show the elementary composition of plants, the source of food supply and to some extent the manner in which plants obtain their food. The author seems to think that this leads, as a matter of course, to agricultural chemistry, but on the contrary it is quite as good an introduction to vegetable physiology, or even better. The work was written for use in Great Britain; and in many parts of the United States and Canada the chapter on the derivation of soils from primitive rock would need modification to apply to the drift region.

The work consists of thirty-three simple laboratory experiments with only enough text to bind them together. They would be most excellent for high school work, or any elementary course where pupils are under the guidance of a teacher.

Minor Notices.

A SMALL WORK on vegetable culture, by Alexander Dean,[2] has come to us for notice. It is a concise manual for pactical instructions for raising the vegetables in ordinary use in Great Britain, but is not specially applicable to the conditions and requirements in America. It will interest those who are curious about the methods of English culinary gardening, as the work is well written.

THE WORK of Arthur and Bolley on *Bacteriosis of Carnations*, issued as bulletin 59 of Purdue University, deserves more than the pass-

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[1] LAURIE, A. P.—The food of plants: an introduction to agricultural chemistry. London and New York, Macmillan & Co. 1893. 16mo. pp. ix+77. Illustrated.

[2] DEAN, ALEXANDER.—Vegetable culture: a primer for amateurs, cottagers, and allotment-holders. Edited by J. Wright. London and New York, Macmillan & Co., 1896. 16mo. pp. 136. 38 illust. in text. 35 cents.

ing notice on p. 252 which the senior author gave it. Although preliminary notices of this work have been given in various places, the full paper is now published for the first time with adequate illustrations and is particularly important as making known the symptoms, nature, and preventive treatment of another bacterial disease. The disease was discovered by Dr. Arthur in 1887-8. In January, 1889, Mr. Bolley's work began and continued for about a year and a half, since which time Dr. Arthur has continued the investigation.

Bacteriosis is a widespread disease of carnations, affecting primarily the leaves, thereby checking growth and productiveness. It is caused by a parasitic bacterium, entering the plant from the air through stomata or the punctures of aphides, which has been isolated and described as a new species, *Bacterium Dianthi.* The disease shows itself first by producing minute translucent yellowish spots, visible when the leaf is looked at against a strong light. These spread and the leaf finally withers and dries up. Other pinks may be artificially infected but the chief damage is to carnations, especially old and weak or poorly grown plants. It may be almost wholly prevented by keeping the foliage dry and free from aphides. Wire netting bent into Λ-shape and placed between the rows of plants supports the foliage and permits proper watering without wetting the leaves. Overhead spraying should be done occasionally on bright days with water containing a small amount of ammoniacal copper carbonate.

The paper is illustrated by eight plates, of which two are remarkably fine chromolithographs. The four drawn by Mr. Bolley are rather crude. Two others are half-tones, showing proper methods of growing in houses at Lafayette, Ind., and Queens, N. Y.

NOTES AND NEWS.

MR. WM. L. BRAY sails for Berlin about the middle of July to be abroad a year.

DR. VICTOR SCHIFFNER has been called to the professorship of systematic botany at the German University of Prague.

A LIST of the orchids grown in the Botanic Gardens of Jamaica is given in the *Bulletin of the Bot. Dept. Jamaica*, for April. It numbers 256 species belonging to eighty-one genera.

THE BOTANISTS of Vermont have organized what seems to be a very vigorous state botanical club, which held its first winter meeting last February at the Museum of the University of Vermont.

PROFS. J. C. ARTHUR and D. T. MacDougal sailed for Europe early in June. Dr. Arthur will spend the summer at Bonn with Strasburger and Prof. MacDougal at Tübingen with Vöchting.

MR. T. D. A. COCKERELL has announced the proposed establishment of a biological station in New Mexico, as a "health and holiday resort for scientific persons." He may be addressed at Las Cruces, New Mexico.

PROFESSOR E. L. GREENE, in *Pittonia* (May 16), has given a history of *Viola pedata*, var. *bicolor;* showing that the variety is really the *V. pedata* L., and that the *V. pedata* of American authors was a form discovered much later, for which he proposes the name var. *inornata.*

DR. N. L. BRITTON, professor of botany in Columbia University has been appointed director of the New York Botanical Garden, and the place so made vacant has been filled by the appointment of Dr. Lucien M. Underwood, now professor of botany in Alabama Polytechnic Institute.

PROF. W. WHITMAN BAILEY has been appointed by President Cleveland a member of the Board of Visitors to the West Point Military Academy. Prof. Bailey was born at West Point in 1843, the youngest son of Prof. J. W. Bailey the microscopist, who was a graduate of the Academy.

AN ILLUSTRATION of *Erythronium Johnsoni* Bolander, of the Coast Ranges of southern Oregon, is published in *The Gardeners' Chronicle* (May 2). In the same number the fertile cones of the African *Sequoia* (*Wellingtonia*) *gigantea* and the Californian *S. sempervirens* are illustrated, showing also individual bracts and ovules.

THE UNIVERSITY OF WISCONSIN at its summer school, July 6th–August 14th, offers laboratory courses in the physiology of plants and in general morphology of plants, both with special reference to the adaptation of the work to the high school. Special courses can also be arranged by advanced students. The work is under the direction of Prof. C. R. Barnes.

MR. C. G. LLOYD of Cincinnati, Ohio, has distributed a list of 243 fleshy and woody fungi added to his mycological museum during 1895. Mr. Lloyd is so generous in loaning his books and specimens to students, and in other ways, that his request for donations of the larger fungi, especially of such as preserve their characters when dried, should meet with a hearty response from collectors.

A *Flora of the Alps*, intended especially for English visitors, is announced for the spring of 1896, from the hand of Mr. Alfred W. Bennett, lecturer on botany at St. Thomas's Hospital, London. It is to form two octavo volumes, with 120 colored plates—not exactly a handy size, one would think, for tourists. The *Flora* will of course include many alpine plants of the adjacent mountain districts of France, Italy, and Austria.

THE NEXT VOLUME in the "Rural Science Series" will probably be Professor Bailey's monograph of *The Apple*. The work is to comprise two parts, the first treating of all the practical matters of apple-growing, and the second of such scientific matters as the botany of the apple, its history and evolution, production of new varieties, and the like. It is expected the work will be completed and ready for publication in the fall.—*Book Reviews.*

THE "Roentgen rays" are compared, in *Gardeners' Chronicle* (May 2), "with the feeble but very penetrating light given out by phosphorescent fungi." Mr. W. G. Smith records having seen the light of phosphorescent mycelia "penetrating several thicknesses of packing paper." In 1875 he "recorded the light as having been distinctly seen through two thicknesses of writing paper;" while in 1872 "the Rev. M. J. Berkeley has recorded an instance of the phosphorescent light from fungi penetrating through five thicknesses of paper, the light penetrating through all the folds on either side of the example, as if the specimen was exposed."

WE ARE INFORMED by M. Cardot that he intends sending to the National Herbarium the original types of most of the American new species of mosses already described by Renauld and himself. He also promises that in the future, whenever it is possible, a type of each new species described will be deposited in this herbarium in order that it may be readily accessible to American bryologists. We take the liberty of expressing the thanks of the students of our moss flora to MM. Renauld and Cardot, for this action, which we are sure will be highly appreciated. We wish the custom might spread among all foreigners who describe new species in any group from this country.

THE BOTANICAL COURSES offered at the summer school of the University of Pennsylvania, beginning July 6th, are as follows:

Ten lectures on "The evolution and distribution of flowering plants," by Dr. Benjamin L. Robinson of Harvard University; two lectures by Dr. John M. Macfarlane of the University of Pennsylvania, on "Timber trees in health," and "Timber trees in decay;" Five lectures on "The natural history of field and garden plants," by Dr. J. W. Harshberger of the University of Pennsylvania; five lectures on "Natural products," by Professor William P. Wilson of the Philadelphia Museums; five lectures on "Fungous diseases of plants," by Professor Byron D. Halsted, of Rutgers College.

Articles of taxonomic interest in the *Journal of Botany* for May are as follows: Cape algæ, illustrated, by Ethel S. Barton; some new Polygalas from Africa, by Dr. R. Chodat; a continuation of Wainio's account of the Elliott collection of lichens from the Antilles, including numerous new species; a revision of the species of *Rosa* of the Babington herbarium, by Francois Crépin, which would serve its purpose better if translated; another fascicle of the never ending British Rubi, by Rev. Augustin Ley; several new species of African *Cyperaceæ;* and an interesting little nomenclature discussion in which our good friend the editor finds himself involved, and which must remind him of some of the strictures he has put upon our American Britton.

Professor George F. Atkinson has been experimenting upon species of *Onoclea*, and showing "that the sporophylls can be made to assume the form and function of the foliar organs by cutting off the latter, thus disturbing the nutrition and forcing the vegetation function on the sporophylls." These results are the occasion of a paper on "The probable influence of disturbed nutrition (carbon-assimilation) on the evolution of the vegetative phase of the sporophyte," printed in *Amer. Nat.* (May), a very suggestive discussion; in which Bower's hypothesis as to the primary character of sporophylls as compared with foliage leaves is sustained, and the influence suggested by means of which carbon-assimilation was gradually transferred from the gametophyte to the sporophyte.

The current number of *Acta Horti Petropolitani* (Vol. XIV. no. 1) contains the following papers: The Potentillas of Central Russia, by A. Petunnikov, illustrated by eleven plates, in which a full discussion of the forms and their natural relationships is given, suggesting bases of classification different from those current; a revision of the genus *Carpesium* (Compositæ), by C. Winkler; an enumeration of plants collected in the mountains of China by Putjata and Bovodowsky in 1891, by J. Palibin, among which are several new species, and the whole list bearing a North American aspect; some new Asiatic Compositæ, among which *Senecio* predominates, by C. Winkler; and notes concerning Asiatic plants, by A. Batalin, in which there are several new species and varieties of *Prunus* and *Lonicera*, and a synopsis of the species of *Dipelta* and *Incarvillea*.

The latest studies among North American plants, as recorded in *Bull. Torr. Bot. Club* (April), are as follows: a provisional list of the species of *Kuhnistera* (*Petalostemon*), by A. A. Heller, giving synonymy and range, and including the description of a new southern species, *K. Gattingeri;* further studies of our southeastern plants, by John K. Small, including a new *Portulaca* and a new *Nymphæa*, and disentangling *Hibiscus lasiocarpus* and *H. grandiflorus;* another presentation of the much discussed forms of *Sisyrinchium* of E. U. S., by Eugene P. Bicknell, reaching the conclusion that there are three species, *S. graminoides* (first printed *gramnoides*, a new name given to the *S. Bermudianum* of Amer. authors, and the *S. anceps* of Watson in Gray's Manual, no old name being available), *S. Atlanticum* (a new species), and *S. angustifolium* Miller; notes on *Meibomia* (*Desmodium*), by Anna Murray Vail; some new and interesting grasses, by F. Lamson-Scribner, and others by Geo. V. Nash.

THE RELATION between calcium and the conduction of carbohydrates has been a subject of investigation by Mr. Percy Groom, who publishes his results in *Annals of Botany* (March). His summary is as follows:

"(1) Acid potassic oxalate retards the action of diastase on starch.

(2) In the living plant the first, and, at the commencement, the only visible effect of acid potassic oxalate on the assimilating organs is the accumulation of starch, owing to an arrest of the change of the starch into sugar.

(3) The second effect, as the soluble oxalate accumulates, is a retardation of the manufacture of starch, and hence probably of the assimilation of carbon.

(4) The last effect, with increased accumulation of the oxalate, is the death of the protoplasm."

All of which indicates that the lack of calcium permits this injurious accumulation of acid potassic oxalate, which otherwise would be neutralized by the manufacture of calcium oxalate.

MACMILLAN & Co. will publish immediately an entirely new edition of *The Nursery Book*, thoroughly recast and revised by the author, Professor L. H. Bailey, of Cornell University. This little manual has been one of the most popular of all current horticultural books and has found a wide circulation both amongst nurserymen and amateurs. Many new illustrations have been made for this edition, bringing the number of cuts up to over 150. It is one of the Garden Craft Series.

The Pruning Book, now in preparation by the same author, will be the next volume in this series. Professor Bailey has been making definite experiments and observations upon this subject for a number of years, and the results of these labors are now approaching readiness for publication. An artist is now employed, under Professor Bailey's direction, in making illustrations for the book which will comprise the entire range of the theory and practice of pruning, both of fruit and ornamental trees and shrubs. It is expected to be on sale early in 1897 or before.

Macmillan & Co. also announce for early publication volume I of the Columbia University Botanical Series, entitled *Elementary Botany*, by Dr. Carlton C. Curtis, tutor in botany, Columbia University, with an introduction by Dr. N. L. Britton.

THE HOPKINS SEASIDE LABORATORY of the Leland Stanford Junior University, founded by Mr. Timothy Hopkins in 1892, opens its fifth session Monday, June 15, 1896. The regular course of instruction will continue six weeks, closing July 25th. Investigators and students working without instruction may continue their work through the summer.

The laboratory provides opportunities for investigators who are prepared to carry on researches in morphology or physiology; for students in the departments of zoology and botany in the university, who wish to supplement their work under the favorable conditions of such an institution, and to gain a knowledge of the methods of research in biology; and for students and teachers not members of the university, who desire to pursue biological studies and to become acquainted with the practical methods of laboratory work. For the latter regular courses are conducted in zoology and botany, accompanied by lectures and by individual instruction at the work table.

The instructor in botany is Mr. Walter R. Shaw.

The laboratory is located on a low bluff immediately overlooking the beach at Pacific Grove, a seaside resort on the southern shore of Monterey Bay, two miles west of Monterey. In the immediate vicinity of the laboratory are exceptionally fine collecting grounds. To investigators prepared to carry on original work the use of the laboratory and its equipment is tendered free of charge. Other students pay a moderate fee for the term of six weeks.

The course in botany consists mainly of a comparative study of the principal groups of fresh water and marine algæ, with collateral work in other groups of plants.

THE FOLLOWING STATEMENT concerning the herbarium and botanical library of Columbia University is of general botanical interest. It is taken from the announcement of the "School of Pure Science," just issued.

The herbarium contains about 500,000 specimens, being one of the largest in America; additions are at present made to it at the rate of about 20,000 specimens a year. It comprises: (1) The collections accumulated by Dr. Torrey, which came into the possession of the university at his death in 1873. (2) The collections of Professor C. F. Meisner of Basle, Switzerland, presented to the university about the time of Dr. Torrey's death, by Mr. John J. Crooke. (3) The collections of Dr. A. W. Chapman of Appalachicola, Florida, presented by Mr. Crooke at the same time, containing the types illustrating Dr. Chapman's Flora of the southern United States. (4) The mosses of the late C. F. Austin. (5) The mosses of the late Dr. J. G. Jaeger, recently acquired. (6) Miscellaneous accumulations since Dr. Torrey's death, now making up more than one-third of the whole collection. The herbarium is rich in types of species described by Dr. Torrey, Professer Meisner, Dr. Chapman, Dr. Asa Gray, Mr. Austin, Professor Britton, and Dr. Morong. The various collections are now all arranged in a single series, but each sheet is identified by a designative label or stamp. There are also extensive collections of fruits, seeds, woods, and material illustrating economic botany, placed in cases and drawers.

The portion of the university library classified under botany is shelved in the room containing the herbarium. It now contains 3,700 bound volumes and about 5,000 pamphlets and extracts. These numbers do not, however, represent the whole reference strength of the collection, for all general works, scientific journals and publications of general scientific societies are shelved in the main library. All the regularly published journals devoted to botany are received, and the sets of the most of them are complete.

GENERAL INDEX.

The more important classified entries will be found under the following heads: Diseases, Floras, Host Plants, Journals, Nomenclature, Personals, Reviews.

Names of synonyms are printed in *Italics;* names of new species, etc., in **bold face.**

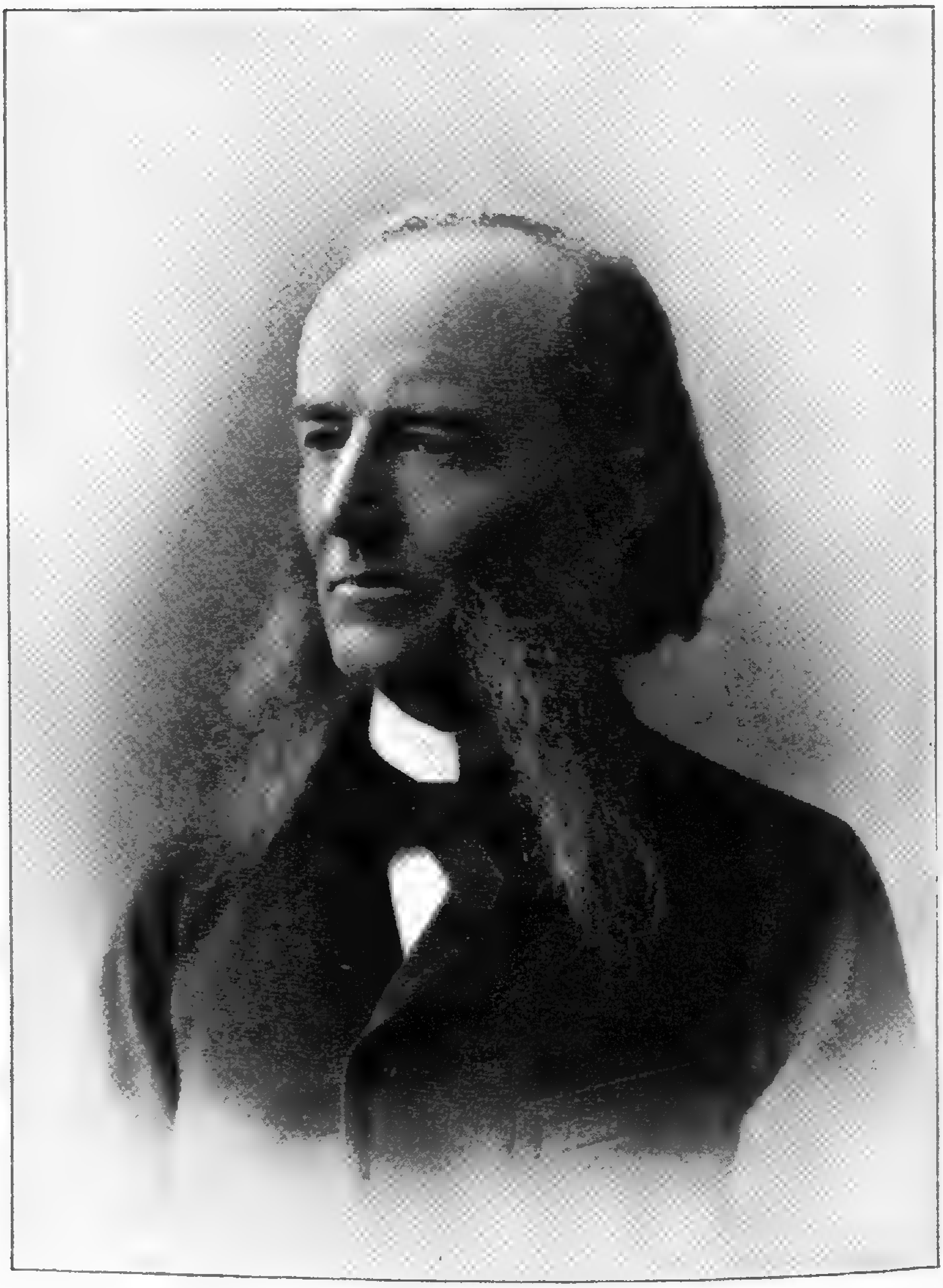
INDEX TO AUTHORS.

BAILEY on CAREX.

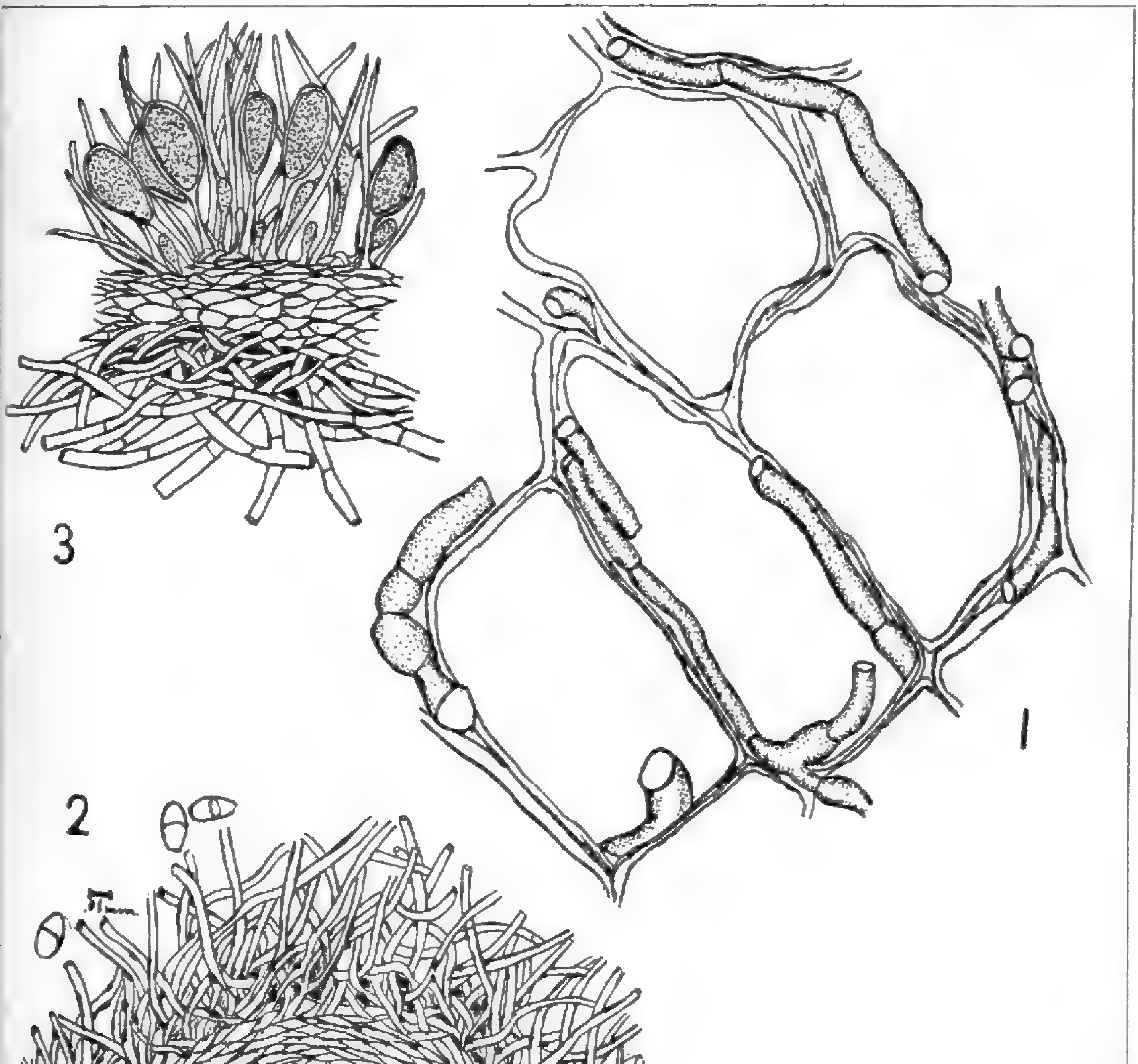
CAMPBELL on GEOTHALLUS.

THAXTER on AQUATIC FUNGI

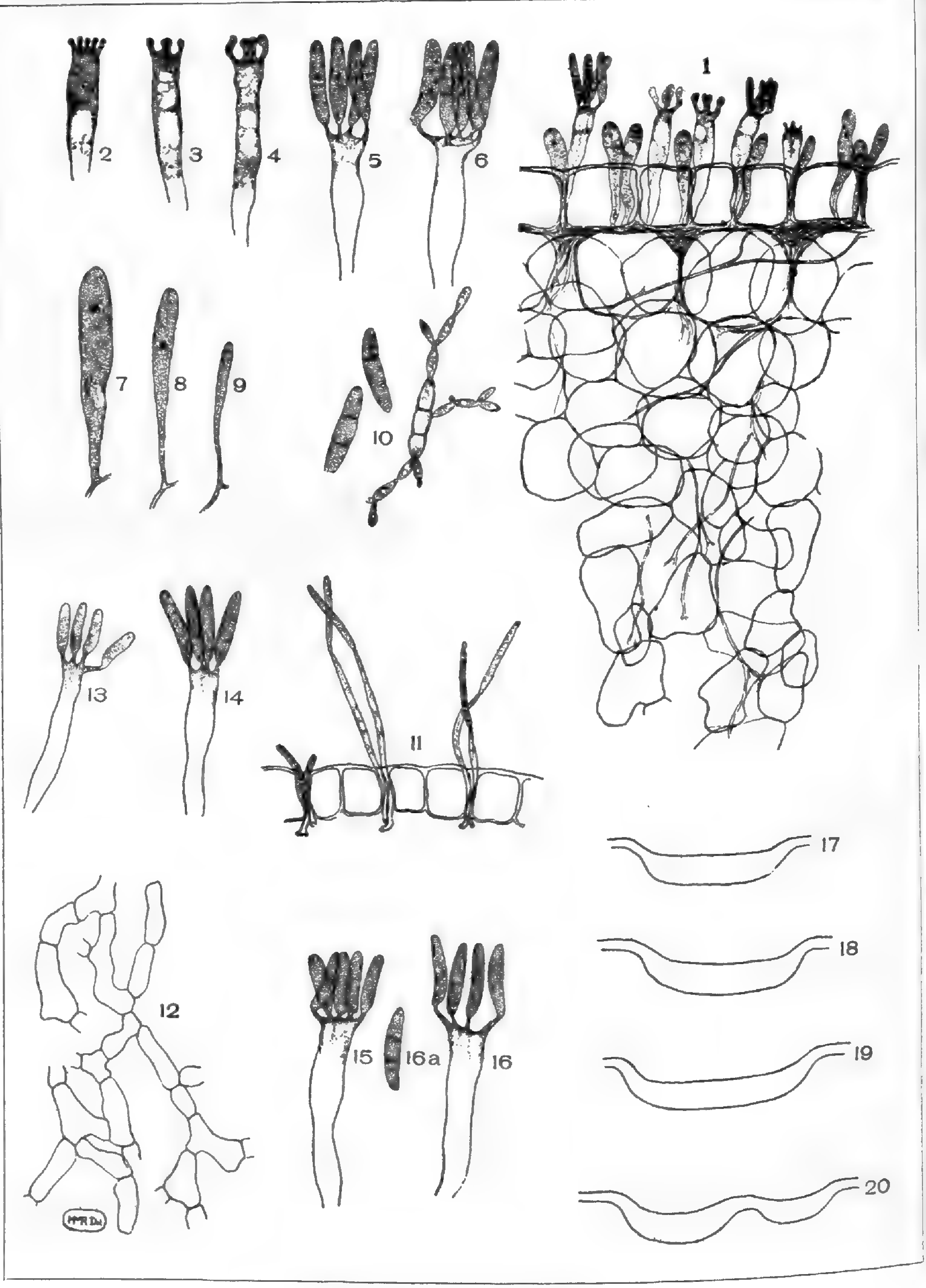
HELIOTYPE PRINTING CO. BOSTON



MICHAEL SCHUCK BEBB.

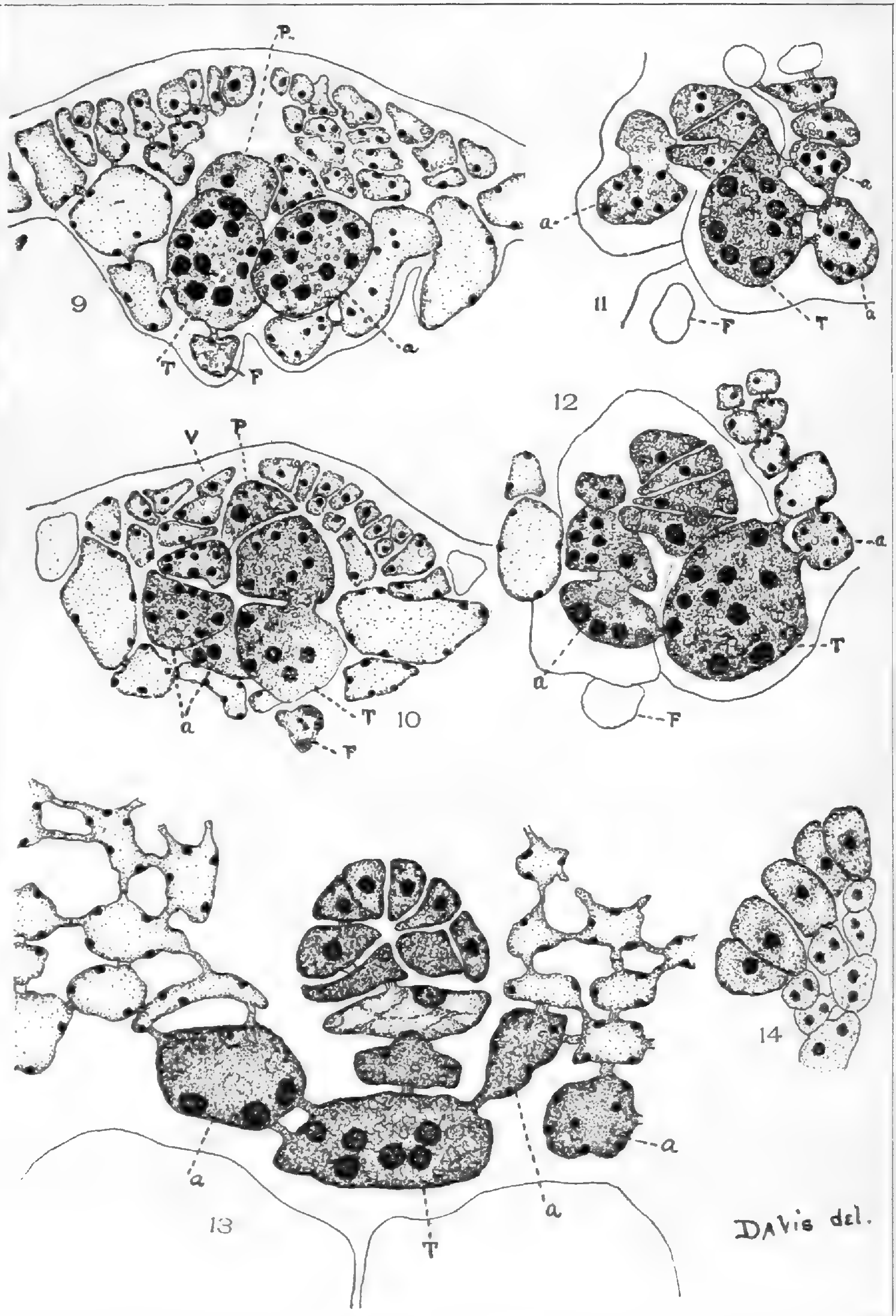


CLENDENIN on LASIODIPLODIA.



RICHARDS on EXOBASIDIUM.

DAVIS on CHAMPIA.



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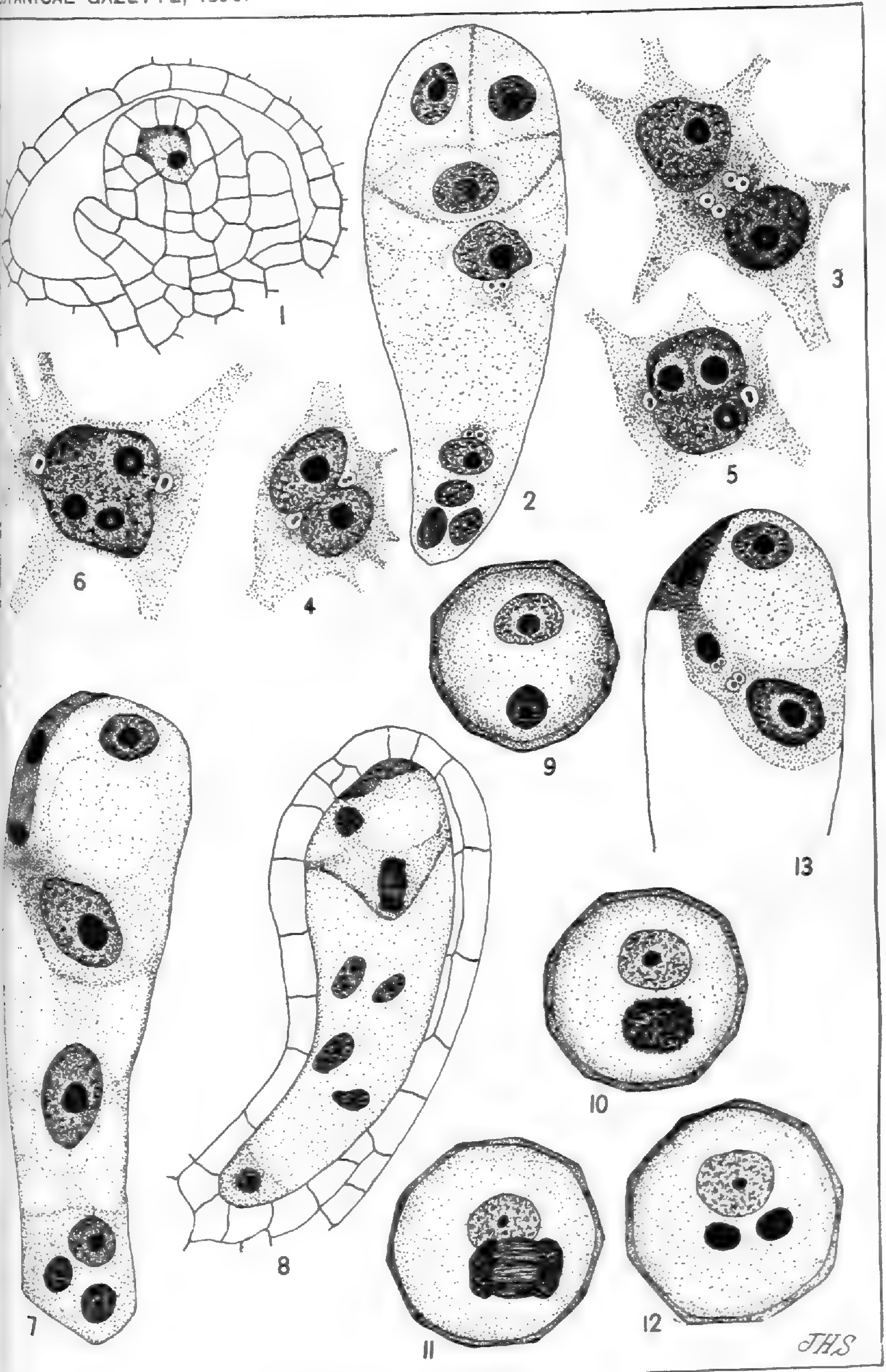
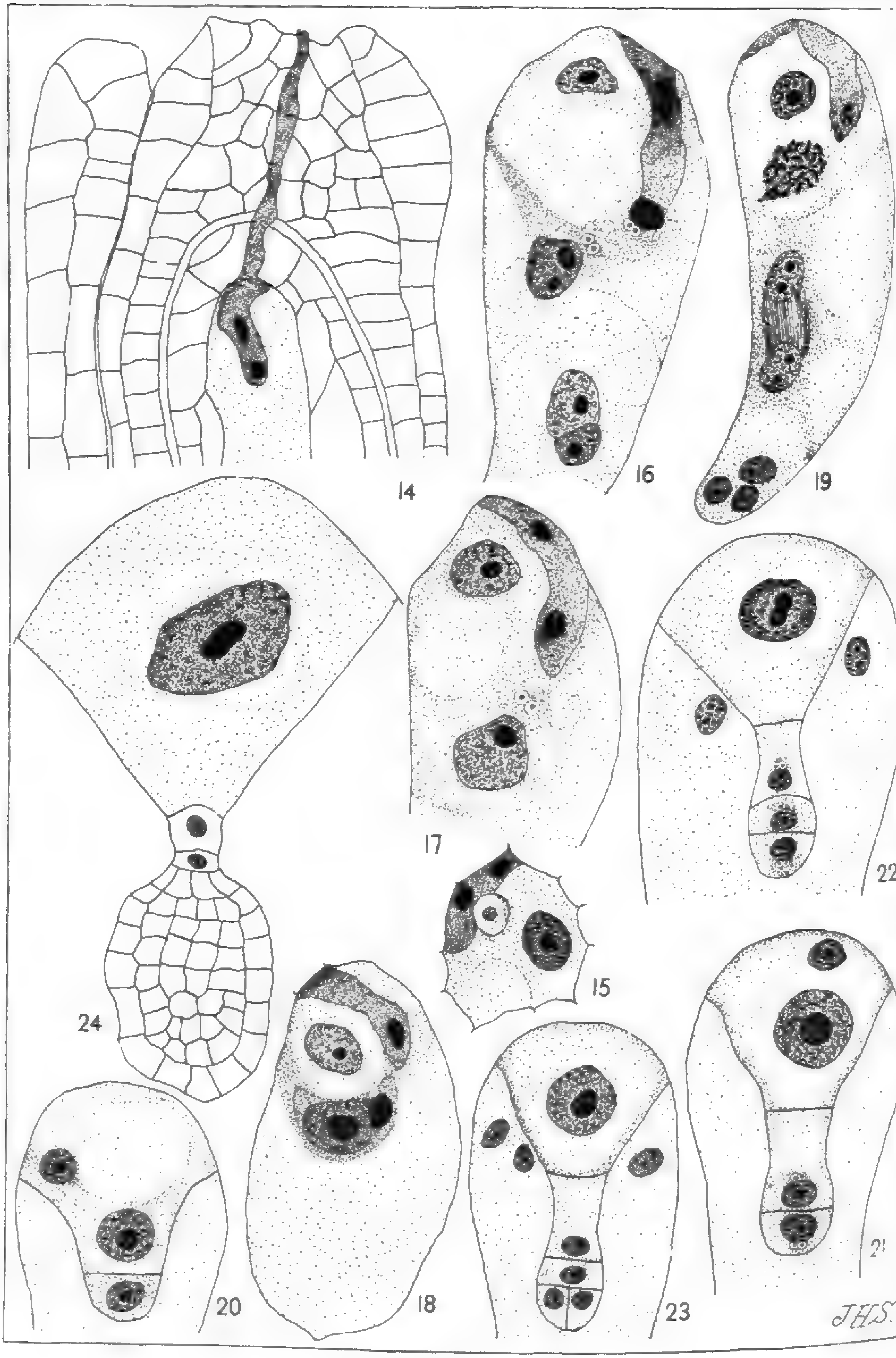


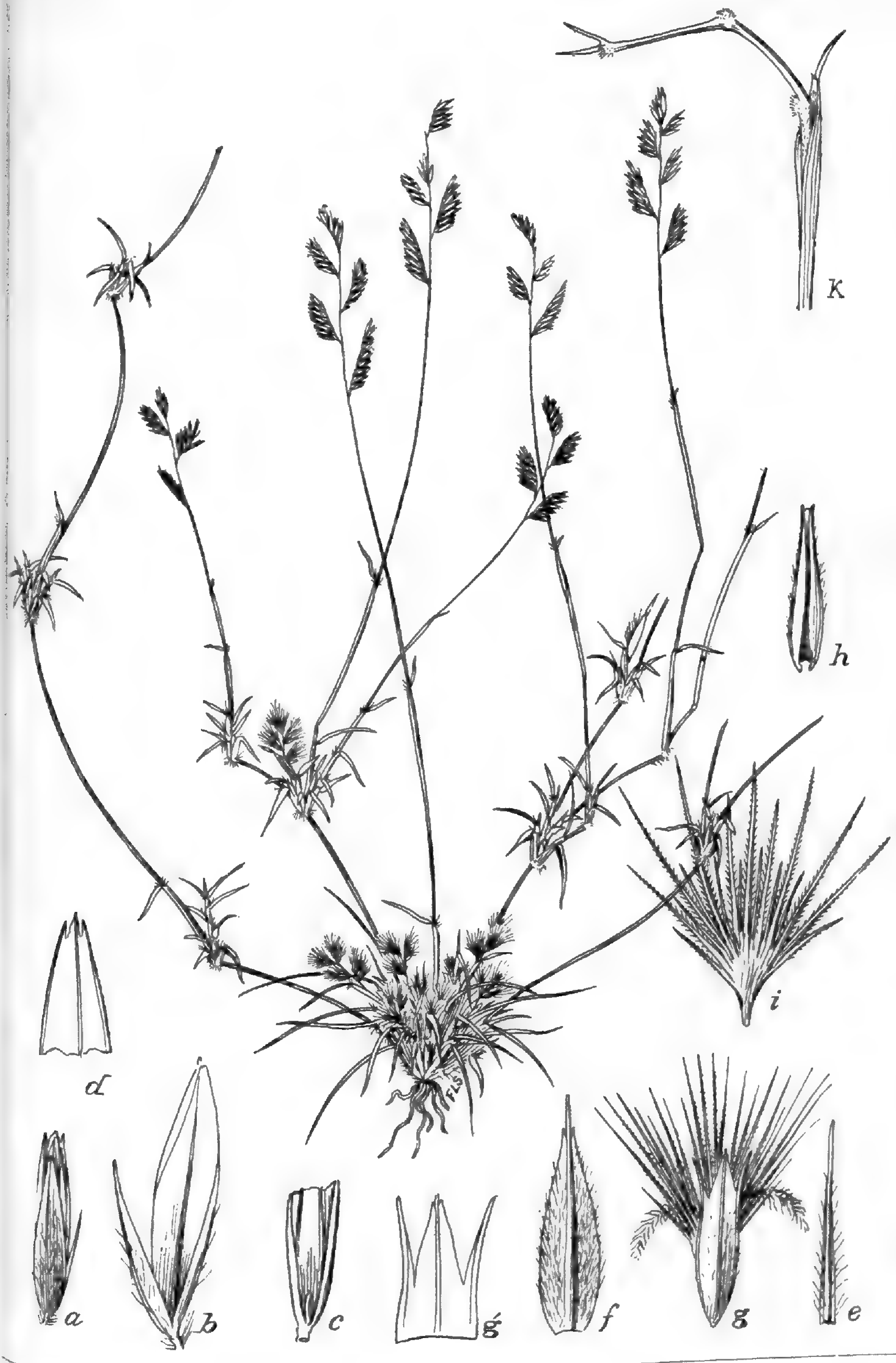
SCHAFFNER on ALISMA.



SCHAFFNER on ALISMA.

SCRIBNER on AVENA.

SCRIBNER on ZEUGITES.

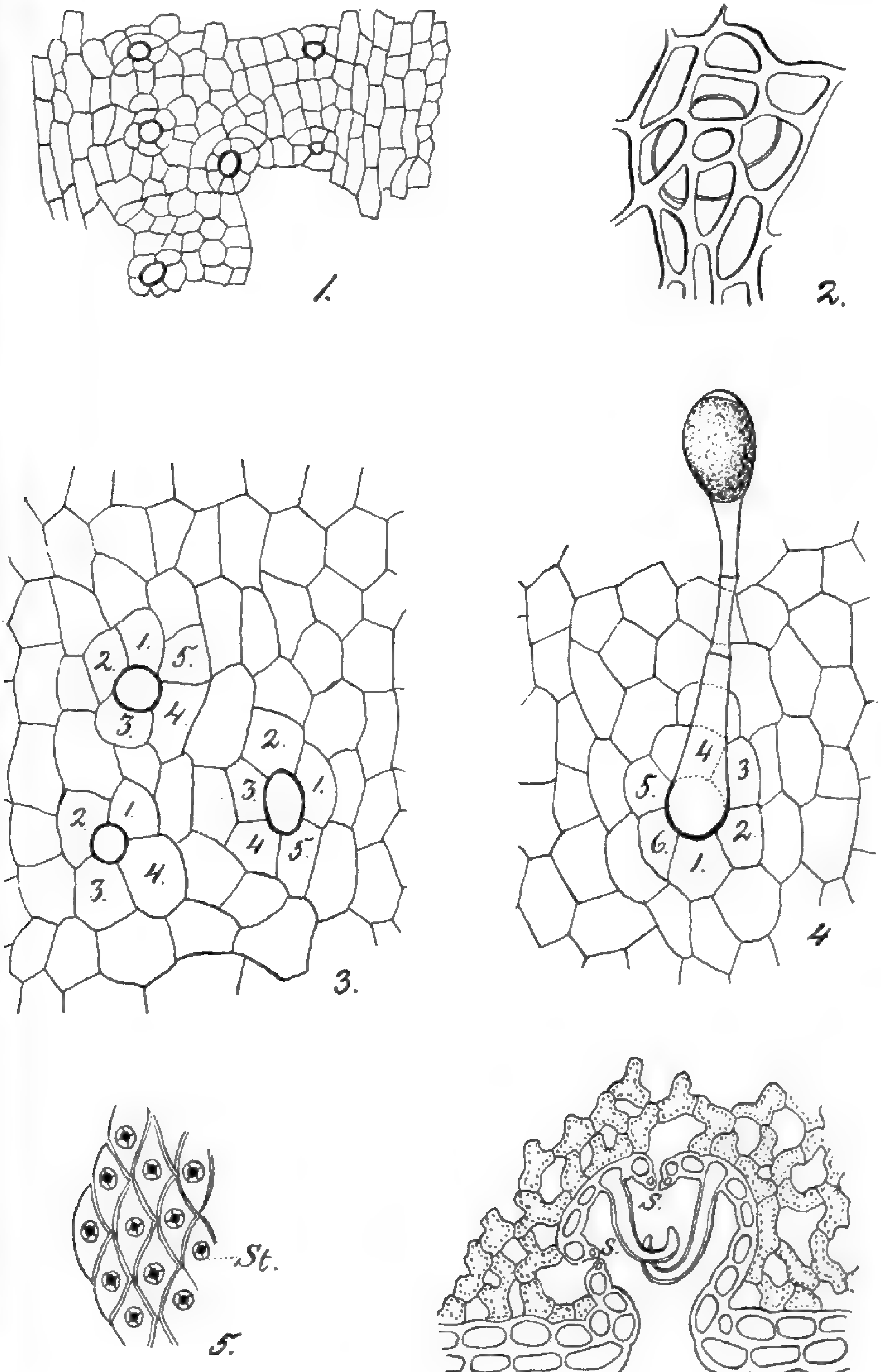


SCRIBNER on PRINGLEOCHLOA.

SHULL on ACCESSORY BUDS.

EVANS on PLAGIOCHILA.

EVANS on PLAGIOCHILA.

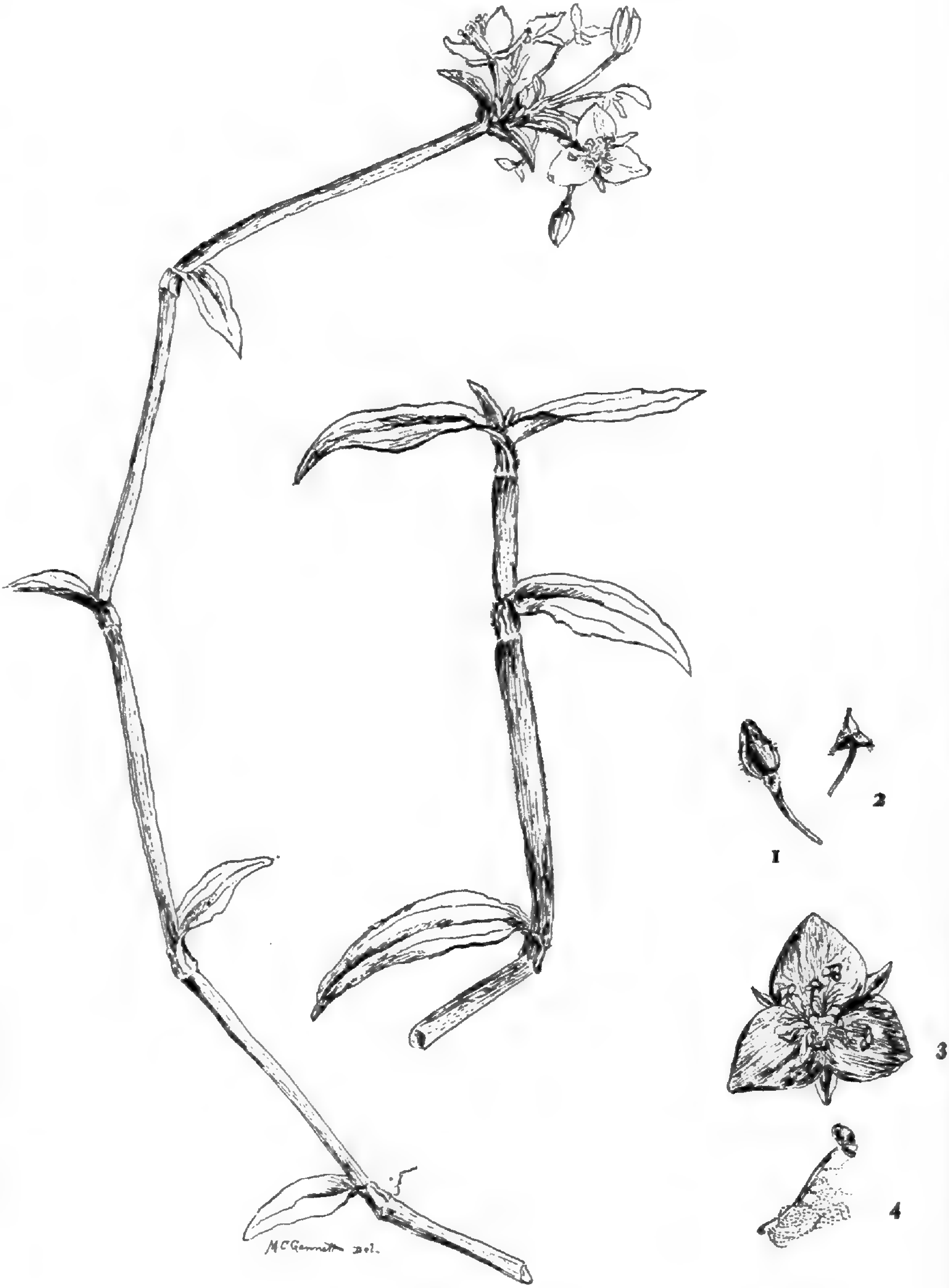


HOLM on PALEOHILLIA.

Faxon del.

DAVENPORT on FILICES MEXICANÆ.

Sincerely Yours,
A. N. Prentiss



ROSE on TRADESCANTIA.

HELIOTYPE PRINTING CO. BOSTON.

THAXTER on AQUATIC FUNGI.

HELIOTYPE PRINTING CO. BOSTON

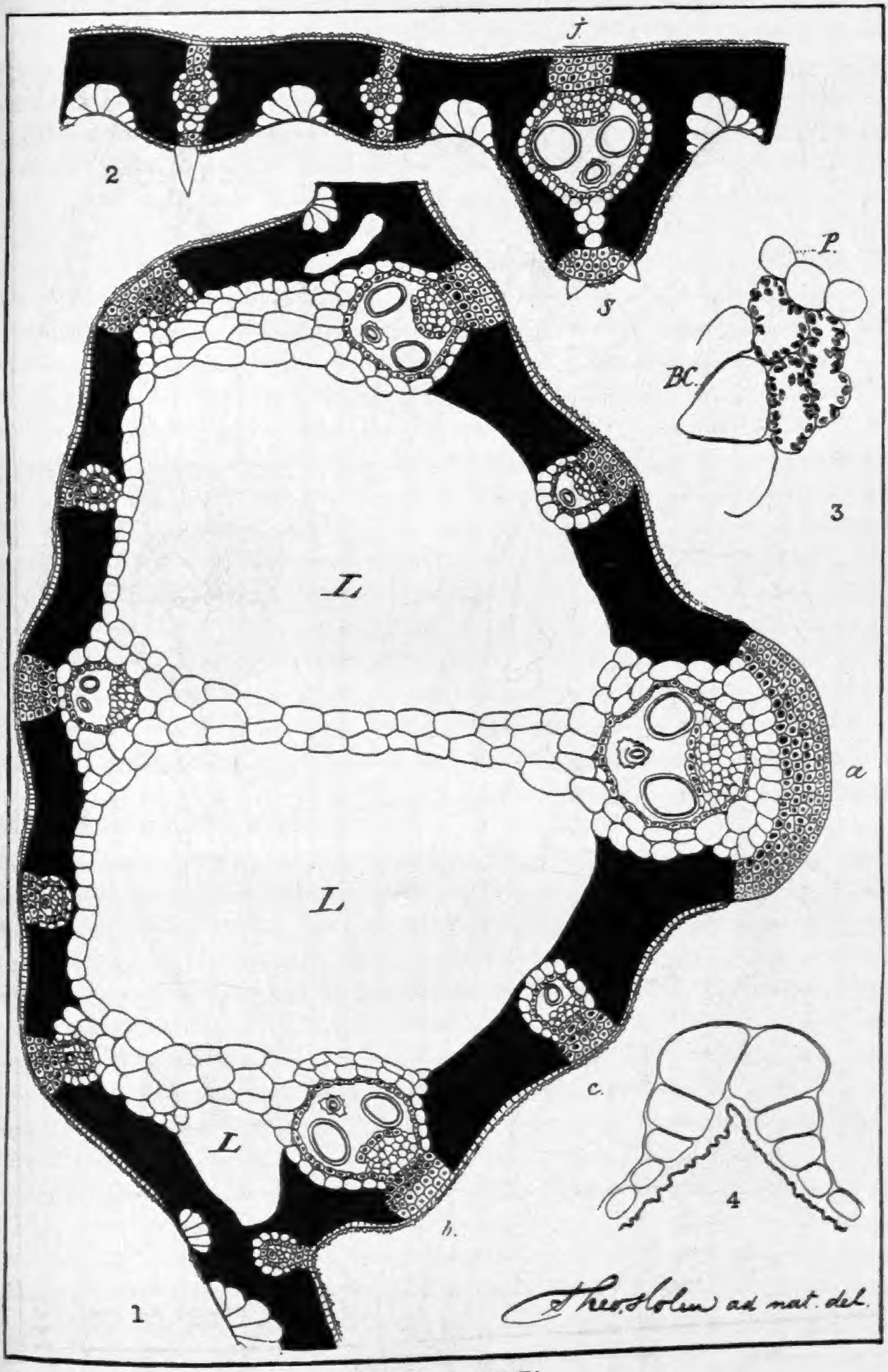
THAXTER on AQUATIC FUNGI.

THAXTER on AQUATIC FUNGI.

SHAW on SEQUOIA.

CHESTER on NEMALION.

CHESTER on NEMALION.



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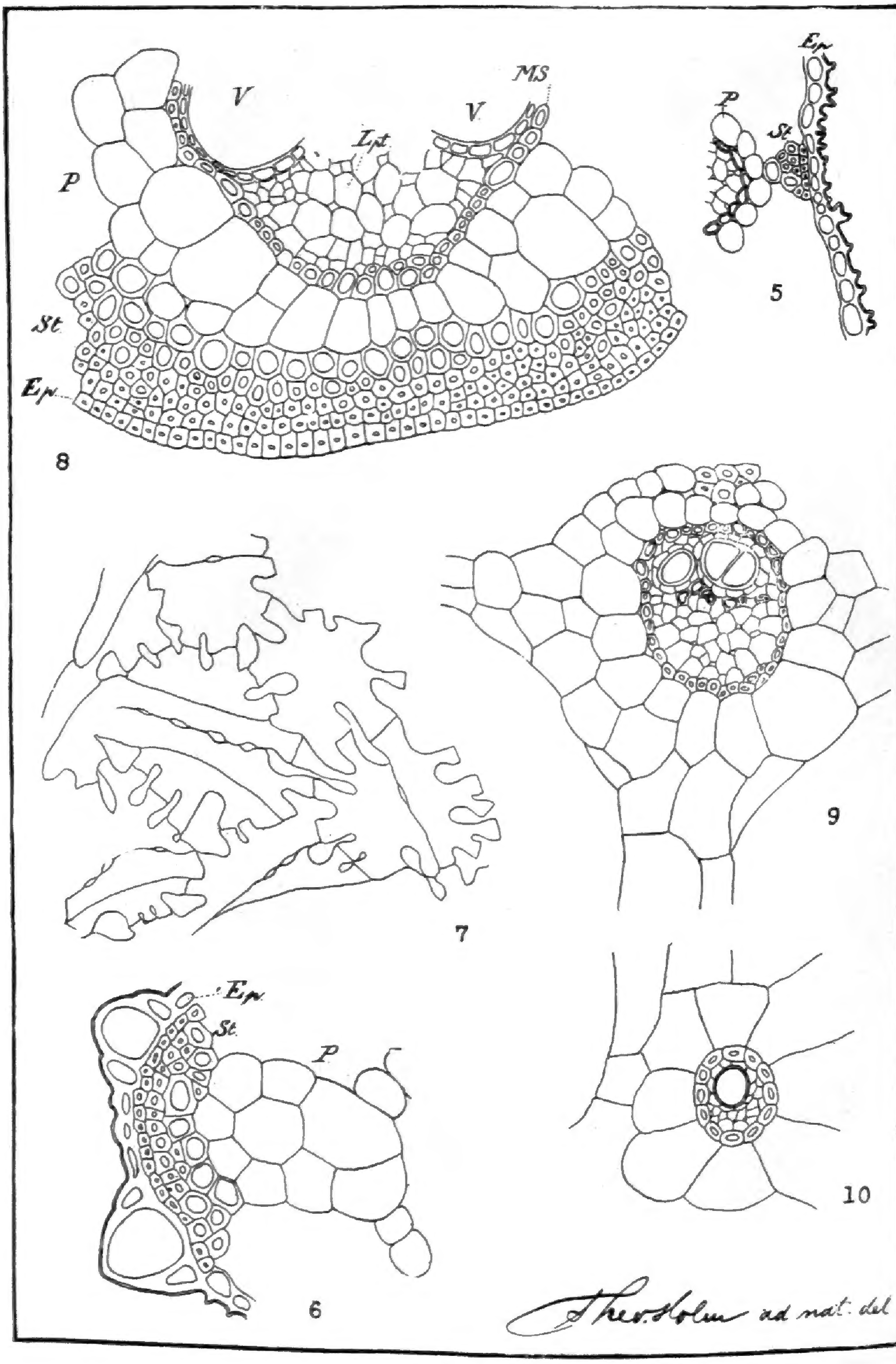

HOLM on ORYZA.

SMITH on CTENIUM.