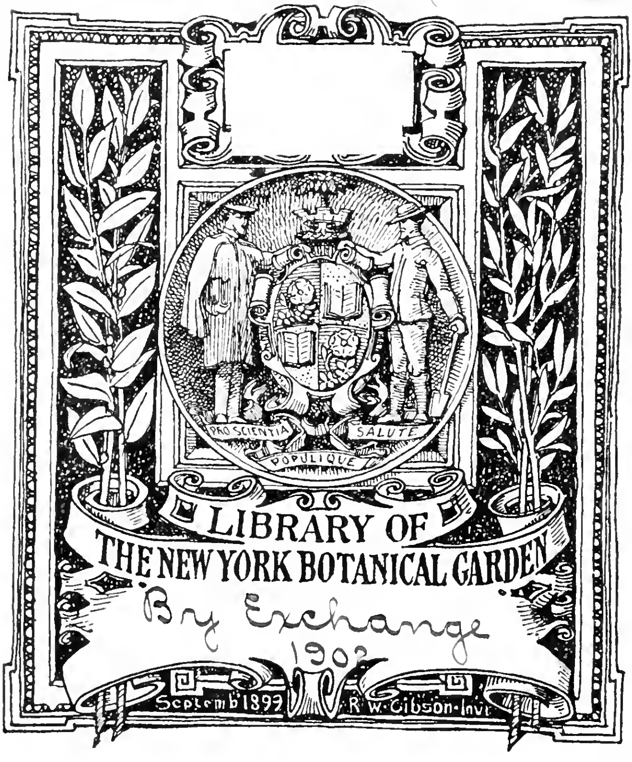

CONTRIBUTIONS

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CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.

No. 101.

The Genus Cephalozia in North America.

By Lucien M. Underwood.

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The Genus Cephalozia in North America.

By Lucien M. Underwood.

The Trigonantheae as outlined by Richard Spruce form a somewhat natural group of the Jungermaniaceae. With us the species are all foliose, but in certain neo-tropical genera the gametophyte is reduced almost to the condition of protonema, producing leaves only on the branches bearing the sex apparatus. In the Australasian genus *Zoopsis*, the simple thalloid shoot in some species is provided with rudimentary leaves only, formed of one or two cells. The tribe, therefore, contains within itself, some of the connecting links which ally the more usual forms to the simple primitive hepatics.

The tribe is characterized by the archegonia being borne on a usually short ventral branch,* with a normally triangular perianth, so placed that the third or odd angle is ventral, the remaining two being lateral. The underleaves are usually wanting or small, only attaining the dignity of a third series of leaves in some of the species of *Lepidozia*, though in *Bazzania* and *Kantia* they are well marked structures. The tribe contains some species that form conspicuous mats like *Bazzania*, but others are small, minute or even microscopic in size. They inhabit old logs, or grow on the ground in swamps, on clay banks or occasionally even in sand and on the faces of moss-covered rocks, but with us are rarely, if ever, found on erect trees, where the species of *Frullania*, *Lejeunea*, *Radula*

* Exceptions to this occur in some rare species of *Cephalozia* where they are terminal.

and *Porella* are most abundant. One species is semi-aquatic in bogs.

Schiffner* recognizes twenty-six genera. Strongly in contrast with this arrangement is that of Spruce,† in which ten of the genera recognized by Schiffner appear as sub-genera of *Cephalozia*. Probably a more rational arrangement would be reached in a mean between these two somewhat extreme views.

The genera represented in temperate and boreal North America may be separated by the following artificial synopsis based on forms lacking the sporophyte or perianth as species are often met with in this condition :‡

Leaves succubous or rarely transverse ; plants small or minute (except in some species of *Odontoschisma*).
- eaves deeply bidentate or bifid.
  - Underleaves rarely present except on perianth-bearing branches. CEPHALOZIA.
  - Underleaves well developed.
    - Without root hairs; underleaves like those of the stem. HYGROBIELLA.
    - With root-hairs; underleaves undivided. PLEUROCLADA.
- Leaves rounded, entire or nearly so. ODONTOSCHISMA.

Leaves incubous ; plants larger, often conspicuous (except in *Lepidozia*).
- Leaves rounded, entire or minutely two-toothed ; perianth wanting, the sporophyte rising from a buried pouch. KANTIA.
- Leaves narrowed toward the end, usually 3-toothed. BAZZANIA.
- Leaves palmately 3-4-cleft or divided. LEPIDOZIA.

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* Hepaticae, in Engler-Prantl: Die natürl. Pflanzenfam. 13 : 94–103. 1893.

† On Cephalozia. 1882.

‡ The question so frequently asked by those who collect mosses is again answered here : "Why is it that we find hepatics so rarely in fruit?" In the first place the "fruit" (*sporophyte*) of the hepatic is less conspicuous than that of the true mosses and the seta is often short. The first answer then is : "Because you overlook it." In the second place there is a fundamental difference between the sporophyte of the hepatic and that of mosses. In the mosses the capsule develops after the seta ; the seta is, therefore, a somewhat permanent structure and the moss remains "in fruit" for a considerable length of time. In the hepatic the capsule develops within the calyptra (which in turn is surrounded by the perianth) until fully mature when the seta develops, pushing through the calyptra ; the seta is, therefore, a temporary and usually ephemeral structure, often withering away soon after the spores are scattered. The perianth is a more permanent structure, and specific and even generic characters are founded on it. Some stage of its development can usually be found in most hepatics. Except in a few cases the characters of the sporophyte are unimportant from a taxonomic standpoint when generic and specific limits are considered, a condition of things widely different from that which obtains among the mosses.

Of the above genera, *Hygrobiella* is represented by three north European species one of which *H. laxifolia* (Hook.) Spruce has recently been sent in from Idaho collected by Sandberg ; it is also found in Greenland; *Pleuroclada*, a monotypic genus of boreal regions, has been found by Macoun in the Rocky Mts. of British America ; *Odontoschisma* has three American species as known at present; *Kantia* is represented by four American species, one of them, *K. arguta* (N. & M.) Lindb., introduced in greenhouses;* *Bazannia*, so abundantly represented in tropical and south Temperate regions, has with us the two northern species that are likewise common in Europe; and *Lepidozia*, likewise a large genus of universal distribution, has with us only three species.†

The remaining genus, *Cephalozia*, is the largest and the most widely distributed genus of the tribe on our continent. The European species were somewhat increased in number by the researches of Lindberg in Scandanavia, and the greater part of the tangled synonomy, to which Lindberg also contributed, was worked out by Spruce in 1882, athough he added to the tangle by knowingly giving to one species the same name that Lindberg had already given (unwittingly) to another species! The latest curiosity in the nomenclature of the genus is that expressed by Schiffner,‡ who, after establishing all of Spruce's subgenera as genera, rejected the old generic name, *Cephalozia*, which has been in use for over a half century, and adopted the subgeneric name *Eucephalozia*, first used by Spruce in 1882 to designate the typical members of the genus, as a generic name!

Cephalozia was proposed as a section of *Jungermania* by Dumortier in 1831 and was erected into a distinct genus by the same

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**Kantia aquatica* Underw. in Hep. Amer. (exsic.) no. 107, is a curious submerged form of *Lejeunea* (probably *L. serpyllifolia*) which has lost its basal lobes, apparently a case of reversion resulting from its abnormal habitat. Herr Stephani discovered rudiments of a perianth in one specimen which led to the determination of the true relations of this curious form.

†*L. chaetophylla tenuis* Pears. cited by Evans (Bull. Torr. Bot. Club, 20: 308 1893), is a true *Blepharostoma* and must be known as *B. nematodes* (Aust.). It is *Cephalozia nematodes* Aust. Bull. Torr. Bot. Club, 6: 302. 1879. *L. Californica* Aust. Bull Torr. Bot. Club, 6: 19, 1875, is of course *Ptilidium Californicum*.

‡*Loc. cit.* 97. A few such anarchistic movements in nomenclature, exceeding anything produced in this country with all its objectionable "*Freiheit*," and entirely without reason or warrant, mar this otherwise excellent work.

author in 1835 with *Jungermania byssacea* Roth. as a type species. It was not accepted by the authors of the Synopsis Hepaticarum 1844-7, but the same is true of many other early genera not proposed by Nees, one of the authors of the work. It was afterwards accepted by Gottsche, and later hepaticologists have accepted it without question, Schiffner alone excepted, as above stated. Of its sub-genera, as noted below, *Nowellia* differs most widely in its general facies from the rest of the genus, but none of the groups seem sufficiently separate for generic distinction. The genus as here recognized can be characterized as follows:

CEPHALOZIA Dumort.

Gametophyte mostly small or minute, usually close-creeping; stems branching ventrally or rarely laterally, often flagelliferous; leaves obliquely placed, succubous, bifid from one-third to over one-half their length; leaf cells usually large, transparent, mostly hexagonal; under-leaves usually wanting on the stems, often present on perianth-bearing branches. Perianth long, triangular, with a narrowed, toothed or ciliate mouth.

Sporophyte an oval or oblong-cylindric capsule on an ephemeral seta, varying in different species from 2 mm. to 2 cm. long.

The genus includes some sixty species well distributed, but best known from the North Temperate zone. Fourteen species are found in America north of Mexico. These can be distinguished by the following table, which has been constructed with special reference to material in which the perianth characters can not be seen:

Leaves deeply concave or somewhat saccate with two long, curved, slender divisions; perianth on a short ventral branch. § NOWELLIA.

Leaf cells 20–25 μ, isodiametric 1. *C. curvifolia.*

Leaves not deeply concave nor saccate.

Branching ventral; leaves bifid, but the leaf margins otherwise entire.

Leaves wider than the stem; involucral leaves not united. § EUCEPHALOZIA.

Leaves small, 0.35 mm. or less long.

Leaves wide (0.35–0.4 mm.) decurrent at base; leaf-cells 35–40 μ; dioicous; perianth fleshy (3 cells thick at base.) 2. *C. media.*

Leaves narrow (0.2–0.25 mm.) not decurrent at base; leaf-cells 20–30 μ; perianth thin.

Leaves strongly narrowed above the base; perianth obovate-oblong. 3. *C. Sullivantiae.*

Leaves not specially narrowed above the base.

Perianth linear-fusiform, widest below the middle; dioicous. 4. *C. catenulata.*

Perianth linear-clavate, widest above the middle; dioicous or autoicous. 5. *C. Virginiana.*

Leaves medium size, 0.5–0.65 mm. long; leaf-cells 40–50 μ.

Leaves longer than broad, cleft half way to the base or more; perianth thin.

Smaller; leaves 0.5 mm. or less long; usually monoicous. 6. *C. bicuspidata.*

Larger; leaves 0.65 long with apiculate divisions; dioicous. 7. *C. extensa.*

Leaves as broad or broader than long; monoicous; perianth fleshy, usually narrowed at base. 8. *C. pleniceps.*

Leaves larger, 1–1.35 mm. long, usually narrowed at base; plant semi-aquatic. 9. *C. fluitans.*

Leaves only about the width of the stem or even narrower; innermost involucral leaves united into a cup. § CEPHALOZIELLA.

Plants small; stems 2–4 mm. long.

Perianth linear or narrowly fusiform, the mouth denticulate or nearly entire. 10. *C. divaricata.*

Perianth ovate-fusiform, the mouth ciliate. 11. *C. Macounii.*

Plants minute; stems less than 2 mm. long.

Underleaves lanceolate, entire, often present only near the end of the stem. 12. *C. Sullivantii.*

Underleaves everywhere present, the upper ones bifid. 13. *C. minima.*

Branching lateral; leaves bifid with dentate margins; perianth terminal; underleaves usually present. § PRIONOLOBUS.

Leaves complicate-bifid, equitant. 14. *C. Turneri.*

1. CEPHALOZIA CURVIFOLIA (Dicks.) Dumort. Recueil d' Obs. sur les Jung. 18. 1835.

Jungermannia curvifolia Dicks. Pl. Crypt. Brit. 2: 15. *pl. 5, f. 7.* 1790.

Nowellia curvifolia Mitt. in Godman, Nat. His. Açores, 321. 1870.

Gametophyte a green or reddish slender creeping leafy axis, sparingly branching; leaves somewhat orbicular, deeply concave, with two slender incurved teeth widely separated at base and soon becoming one cell wide; underleaves wanting; leaf cells isodiametric, 20–25 μ in diameter: monoicous or dioicous; perianth on a short branch, triangular-prismatic, about 1.3 mm. long, plicate, with the mouth constricted and short ciliate; involucral leaves in two or three rows, deeply bifid with broad serrulate divisions.

Sporophyte a dark brown oval capsule 0.7–0.8 mm. long, on a short seta 0.5–2 cm. high; spores 6–8 μ in diameter, nearly spherical, dark brown; elaters 250 long, wider than the spores, bispiral.

A very common species on rotten wood distributed from the mountain region of Georgia to Wisconsin and northeastward; also European.

It has been distributed by Sullivant: Musc. Alleg. 242 (as *Jungermannia curvifolia*); Austin: Hep. Bor.-Am. 60; and in Hep. Amer. 17. Several figures exist; of these, Hooker, Brit. Jung. *pl. 15*, and Suppl. *pl. 1*, and Ekart, Syn. Hep. Germ. *pl. 8. f. 59*, are among the best; that in Smith, Eng. Bot. *pl. 1304* poorly represents the plant.

2. Cephalozia media Lindb. Medd. Soc. Faun. et Fl. Fenn. 6: 242. 1881.

Cephalozia multiflora Spruce, On Cephalozia, 37. 1882 (not of Lindb.).

Gametophyte a slender creeping, usually pale green leafy stem; leaves often wider than long, decurrent, slightly imbricate, bifid one third their length with an obtuse or rarely lunate sinus and acute connivent segments; leaf-cells mostly uniform, 36–40 μ in diameter: dioicous; perianth on a very short branch, linear-fusiform, fleshy, formed of three layers of cells at base and two above; antheridia usually near the apex of a branch. Sporophyte a short-stalked, oblong-cylindric capsule enclosed at first in a fleshy calyptra formed of three layers of cells; spores cinnamon-colored.

One of our most common species growing in large patches on decaying logs and rarely on the ground from Florida to Virginia, California and generally distributed over the northern portion of America; also European. The species was long confused with *C. connivens* (Dicks.) both in this country and in Europe. During this period it was distributed under the original name of *Jungermannia connivens* by Sullivant. Musc. Alleg. 246, and as *Cephalozia connivens* by Austin, Hep. Bor.-Am. 57. Lindberg, thinking that this species was the true *C. connivens*, gave to that species the name of *C. multiflora*. Later, Spruce, identifying the true *C. connivens*, unfortunately gave the same name (*C. multiflora*) to the present species. Under this name the species was distributed by us in Hep. Amer. 38 and by Macoun, Can. Hep. 19* Fortunately Lindberg, a year earlier than Spruce, had given the species a name that will effectually blot out the confusion arising from the use of the homonym, *C. multiflora*.

3. Cephalozia Sullivantiae (Aust.)

Jungermannia Sullivantiae Aust. Bull. Torr. Bot. Club, 3: 12. 1872. (Not *J. Sullivantii* Aust. Proc. Acad. Phila. for 1869: 221. 1869.)

Gametophyte a short, close-creeping, sparingly branched stem; leaves whitish, usually spaced, about 0.3–0.35 mm. long, two-thirds as wide, strongly narrowed just above the base, somewhat ovate, erect, spreading or nearly horizontal, bifid to one-half or two-thirds their length, with obtuse sinus and acute usually divaricate divisions; leaf cells 25–30 μ in diameter; dioicous; perianth at the end of a very short branch, obovate-oblong, 1.2–1.5 mm. long, the mouth deeply 10-cleft; involucral leaves mostly bifid with a large tooth on the outer margin near the middle or towards the base. Sporophyte a short-stalked mostly short oval capsule; mature spores not seen.

Apparently an uncommon species, seen only as yet from Ohio, whence it was distributed by Sullivant: Musc. Alleg. 241 (as *Jungermannia bicuspidata*, var. 2); Austin also reported it from Illinois, but I have seen no specimens. The name is unfortunately too near *C. Sullivantii* and may need change to prevent confusion.

4. Cephalozia catenulata (Hüben.) Spruce, On Cephalozia, 33. 1882.

Jungermannia catenulata Hüben. Hepaticol. Germ. 169. 1834.

Jungermannia reclusa Tayl. Lond. Jour. Bot. 5: 278. 1846.

Cephalozia serriflora Lindb. Medd. Soc. Faun. et Fl. Fenn. 1878.

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* In my set of Macoun's Canadian Hepaticae this species occurs under the following numbers:

No. 39 as *Cephalozia Lammersiana*.

No. 18 as *Cephalozia catenulata*.

No. 20 (mostly) as *Cephalozia pleniceps*.

The species thus appears in one set of exsiccatae under four distinct names! The smaller species of Hepaticae, like *Cephalozia* and *Marsupella*, are likely to grow intermixed, so that the greatest care is necessary in selecting them for issues of exsiccatae wh ch are to be used as works of reference. Spruce has called attention to the similar errors in European exsiccatae, particularly Gottsche and Rabenhorst's Hepaticae Europeae.

Gametophyte a slender creeping stem with pale leaves which are incurved in drying so as to cause the stems to resemble a chain; leaves subimbricate, slightly concave, oval-rotund, cleft one-half their length with a somewhat obtuse sinus and acute, more or less spreading divisions; leaf-cells 22–25 μ in diameter: dioicous; perianth on a short branch, 1.3 mm. long, linear-fusiform, widest below the middle, the mouth ciliolate; antheridia in he axils of the leaves of a short apical spike. Sporophyte a reddish oval-cylindric capsule borne on a short seta.

Somewhat common on the ground and on rotten wood from Newfoundland to British Columbia and probably southward, where it is often confused with the next species; also European. It was distributed by Austin in Hep. Bor. Am. 56.

5. CEPHALOZIA VIRGINIANA Spruce, On Cephalozia, 37. 1882.

Gametophyte a slender creeping whitish stem; leaves contiguous or slightly imbricate, obliquely ovate, cleft about to the middle, with acute or acuminate spreading divisions; leaf-cells isodiametric, about 22 μ in diameter: dioicous or sometimes autoicous; perianth large, linear-clavate, widest above the middle, the mouth constricted and unequally short-setulose; antheridia in the axils of the leaves of a short spike. Sporophyte an oval-cylindric reddish brown capsule on a rather long seta.

Through the kindness of Mr. Pearson I have a fragment of the type specimen described by Spruce from Portsmouth, Virginia. The species appears to be more or less widely distributed through the Southern States, but in the absence of mature perianths is distinguished with difficulty from the preceding species. It was distributed in Hep. Amer. 72.

6. CEPHALOZIA BISCUSPIDATA (L.) Dumort. Recueil d'Obs. sur les Jung. 18. 1835.

Jungermannia bicuspidata L. Sp. Pl. 1132. 1753.

Jungermannia Lammersiana Hüben. Hepaticol. Germ. 165. 1834.

Gametophyte a slender prostrate greenish leafy stem, 1–3 cm, long, flagelliferous branching; leaves distant in the basal portion. imbricate toward the apex, round-ovate, cleft to the middle or beyond, with spreading lanceolate, acute or acuminate lobes; leaf cells uniform, 30–40 μ in diameter: monoicous or in one form dioicous; perianth on a very short branch, about four times the length of the leaves, somewhat fusiform. Sporophyte cylindric-oblong on a short seta; calyptra thin; spores purple.

On rotten wood and on the ground; widely distributed from Newfoundland to British Columbia and southward along the Appalachian area; also reported from California (*Howe*); the species is also European. It was distributed by Sullivant: Musc. Alleg. 240 (as *Jungermannia bicuspidata*); by Austin: Hep. Bor. Am. 58, 59, the latter as var. *conferta*, a form with crowded leaves; and in Hep. Amer. 71. The form known as *C. Lammersiana* found in the British Possessions can hardly be maintained as distinct.

The species has been frequently figured, the best figures being Hooker, Brit. Jung. *pl. 11*, and Suppl. *pl. 4*; Ekart, Syn. Jung. Germ. *pl. 4, f. 23*; and Smith, Engl. Bot. *pl. 2239*.

7. CEPHALOZIA EXTENSA (Tayl.) Spruce, On Cephalozia, 44. 1882.

Jungermannia extensa Tayl. Lond. Jour. Bot. **5**: 279. 1846.

Gametophyte a prostrate pale or rufous, sparingly branched leafy stem; leaves spreading, complicate-concave, those of the basal portion contiguous, those of the apical portion crowded, bifid more than one-half their length, with triangular-lanceolate acuminate and often apiculate divisions; leaf-cells about 35 μ in diameter: dioicous; perianth on a more or less elongated branch, linear-fusiform or sublanceolate, three times the length of the involucral leaves, which are in three or four ranks, deeply cleft and slightly longer than the ordinary stem-leaves. Sporophyte a long-stalked oval capsule, 0.7 mm. long; spores about 9 μ in diameter.

This plant was originally described from material collected by Dr. Scouler at Observatory Inlet, N. W. America and appears from present data to extend from Washington and British Columbia to northern California. It was distributed in Can. Hep. **22**.

8. CEPHALOZIA PLENICEPS (Aust.) Lindb. Medd. Soc. Faun. et Fl. Fenn. **9**: 158. 1883.

Jungermannia pleniceps Aust. Proc. Phila. Acad. for 1869: 222. 1869.

Cephalozia crassiflora Spruce, On Cephalozia, 40. 1882.

Gametophyte a short slender prostrate leafy stem; leaves thick, obliquely orbicular, concave, not decurrent, cleft one-fourth to one-third their length, with acute or somewhat obtuse sinus and acute lobes; leaf-cells rather large, 36–40 μ in diameter: monoicous; perianth terminal on a short branch, 2.6 mm. high, obovate-cylindric, fleshy, three cells thick at base, reduced to two cells above the middle; involucral leaves in about three ranks, appressed, fleshy, composed of two strata of cells near the base; antheridia in the axils of smaller leaves crowded in spikes. Sporophyte a short-stalked oval capsule, 0.8 mm. long, enveloped until maturity in a thin calyptra; spores about 9 μ in diameter.

The type locality of Austin's plant was in the White Mountains of New Hampshire; that of Spruce's *C. crassiflora* in the Pyrenees. It occurs on the mountains of New England and in Canada, and according to Pearson extends westward to British Columbia; also reported from California (*Howe*). It is likely to be confused with *C. media* on account of its thick perianth, which in section is found to be made up of three strata of cells at base, and two strata if the section is made higher up; *C. media* is smaller and dioicous, with strongly decurrent leaves and probably has a much wider range in both latitude and altitude. *C. pleniceps* is also reported from various parts of Europe.

9. CEPHALOZIA FLUITANS (Nees) Spruce. on Cephalozia, 50. 1882.

Jungermania fluitans Nees, in Syll. Ratisb. 129. 1823.

Cephalozia obtusilobata Lindb. Bot. Notiser, 1872: 164. 1872.

Gametophyte a slender elongate axis, growing over *Sphagna* or semi-aquatic; leaves distant, oval, ovate or oblong, somewhat cuneate at base, bilobed one-third to one-half to the base, with a narrow acute sinus and usually obtuse lobes; leaf-cells hexagonal, 40–50 μ in diameter: dioicous; perianth on a short branch, about 3 mm. long, oval, cylindric, trigonal only at the apex; involucral leaves rather smaller than the ordinary stem-leaves, bifid to the middle, with acute lobes. Sporophyte an oblong or oblong-cylindric capsule, on a short seta; spores minutely tuberculate.

Growing in wet places, in Sphagnum bogs or semi-aquatic in the margin of pools, New Jersey and New England to Labrador and northwestward. It has been distributed by Austin in Hep. Bor. Am. 35 (as *Jungermannia inflata* var. *fluitans*) and in Hep. Amer. 154, 173.

10. CEPHALOZIA DIVARICATA (Sm.) Dumort. Hep. Europ. 89. 1874.

Jungermannia divaricata Smith, Engl. Bot. *pl. 719.* 1800.

Jungermannia byssacea Roth, Fl. Germ. 3: 387. 1800.

Jungermannia confervoides Raddi, Mem. Soc. Mod. 18: 29. *pl. 4. f. 1.* 1820.

Jungermannia Starkii Funck; Nees, Europ. Leberm. 2: 215, 225. 1836.

Jungermannia Grimsulana Jack; Gott. et Rabenh. Hep. Europ. No. 56.

Gametophyte a slender green olivaceous or almost black, leafy stem with leaves scarcely wider than its diameter; leaves mostly spaced, especially on sterile stems, cleft about half-way to the base, the lobes complicate or divergent, acute; underleaves mostly wanting: dioicous; perianth linear or narrowly fusiform, sometimes purple toward the base, prismatic, 3–6-angled, the mouth somewhat constricted, denticulate or nearly entire; involucral leaves larger, more or less connate, bifid, the lobes denticulate. Sporophyte an oblong-globose capsule on a short seta.

On sand and rocks and occasionally on rotten wood, New Jersey to Labrador, and on the Pacific coast from California northward; also European. It was distributed by Austin in Hep. Bor. Am. 51, 52, 53, 54; and in Hep. Amer. 155.

The species has been well figured. Besides the figures of Smith and Raddi, noted above, the more important are Hooker. Brit. Jung. *pl. 12* and Ekart, Syn. Jung. Germ. *pl. 4. f. 34.*

11. Cephalozia Macounii (Aust.) Aust. Hep. Bor. Am. no. 55. 1873.

Jungermannia Macounii Aust. Proc. Phila. Acad. for 1869: 222. 1869.

Gametophyte a short creeping more or less branched leafy stem; leaves contiguous or somewhat imbricate, broadly spreading, bifid a little beyond the middle, the lobes spreading and broadly subulate, 2–4 cells wide at base, mostly acute; leaf-cells 15–18 μ in diameter; underleaves wanting: dioicous; perianth about 0.7 mm. long, whitish, ovate-fusiform, the mouth narrowed and ciliate; involucral leaves 2 or 3 pairs, appressed, 2–3-cleft nearly one-half their length, irregularly spinulose. Sporophyte not seen.

On rotten logs, mountains of New England (Austin), Ontario and British Columbia (Macoun). The plant was distributed by Austin: Hep. Bor. Am. 55. The species is rarely collected.

12. Cephalozia Sullivantii (Aust.) Aust. Hep. Bor. Am. No. 50, 1873.

Jungermannia Sullivantii Aust. Proc. Phila. Acad. for 1869: 221. 1869.

Gametophyte an exceedingly minute mostly simple, fleshy stem, often less than a millimeter long; leaves imbricate, ovate-orbicular, usually narrower than the stem, bifid with an acutish sinus; underleaves lanceolate-ovate, entire, often apparent only near the ends of the stems; perianth terminal on ascending stems, 0.5 mm. or less long, oval or somewhat obovate, plicate and truncate at the mouth. Sporophyte an oval capsule on a seta scarcely longer than the perianth.

Among mosses on rotten wood, New Jersey and Ohio (*fide* Austin); also Belleville, Ontario (Macoun). Not often collected but likely to be overlooked by collectors on account of its almost microscopic size. It was distributed by Sullivant: Musc. Alleg. 239 (as *Jungermannia divaricata*); this number forms the type; it was also distributed by Austin: Hep. Bor. Am. 50.

13. CEPHALOZIA MINIMA Aust.; Pearson, List Can. Hep. 11. *pl. 6.* 1890.

Gametophyte a minute dark green, usually simple leafy axis; leaves about the width of the stem, obovate or subquadrate, bifid one-third their length, with acute divisions, the margins entire; leaf cells 4–6-sided, about 16 μ in diameter; underleaves present, the lower entire and subulate, the upper larger and bifid: dioicous; perianth acrocarpus, oblong-oval, with rather wide sub-entire mouth; involucral leaves 3 pairs, larger than the ordinary stem-leaves, subquadrate, bifid one-third to one-half their length, spinulose-dentate; antheridia on short branches. Sporophyte not seen.

On rotten logs, Belleville, Ontario (Macoun); known only from the type specimen.

14. CEPHALOZIA TURNERI (Hook.) Lindb. Acta Soc. Sci. Fenn. 10: 502. 1875.

Jungermannia Turneri Hook. Brit. Jung. *pl. 29.* 1816.

Gametophyte a prostrate slightly branched leafy stem, 2–5 mm. long; leaves approximate, equitant, complicate-bifid half-way to the base, the margin everywhere sharply and unequally serrate-dentate; underleaves wanting: dioicous or monoicous; perianth whitish, 0.3–0.5 mm. long, pentagonal-prismatic, the mouth almost closed, obscurely ciliolate; involucral leaves larger than the ordinary stem-leaves, spinose-dentate, bifid with acute divisions. Sporophyte and oval capsule on a slender seta; spores dark brown, about 8 μ in diameter; elaters dark brown, about 200 μ long, with two close spirals.

This species was first announced by Mr. M. A. Howe from

Marin and San Mateo counties, California,* but a scrap of it had been previously collected (1888) with *Polytrichum* by Miss M. E. Parsons, of San Rafael, and overlooked in my collection. It is found mostly on the ground and is an interesting addition to our flora. It has long been known in Europe, but does not appear to be common. It was distributed in Hep. Am. 174, from fine material sent by Mr. Howe. The species has been illustrated in Smith, Engl. Bot. *pl. 2510* and in Ekart, Syn. Jung. Germ. *pl. 9, f. 69* in addition to the citation of Hooker above.

Species dubiae et inquirendae.

CEPHALOZIA DENTATA (Raddi) Spruce, On Cephalozia, 71. 1882.

Jungermannia dentata Raddi, Mem. Soc. Mod **18**: *22. pl. 4. f. 4.* 1818.

(This species was reported by Mitten, Jour. Linn. Soc. **8**: 52, 1865, under the name *Trigonanthus dentatus*, from Galton Mountains, British Columbia, but as it is not otherwise known from North America the identification needs to be verified.)

CEPHALOZIA CONNIVENS (Dicks.) Dumort, Recueil d' Obs. sur les Jung. 18. 1835.

Jungermannia connivens Dicks. Pl. Crypt. Brit. fasc. **4**: 19. *pl. 11. f. 15.* 1801.

Cephalozia multiflora Lindb. Acta Soc. Sci. Fenn. **10**: 501. 1875. (not Spruce *l. c.*)

(This species has been frequently reported from America but has been confused with *C. media*. It is likely to occur northward and can be distinguished from that species by its large leaf-cells (66 μ in diameter) and its perianth formed of a single layer of cells, with long ciliate mouth.)

* * *

The publication of a revision like the above is often accepted by botanical collectors as an indication that the information regarding the genus is closed. As a fact such a revision merely indicates the extent of our knowledge for the present and forms a datum line for further study. It also shows or ought to show the limitations of our knowledge. The remarks to follow apply not only to the genus *Cephalozia*, but to all genera and species of He-

* Erythea, **4**: 50. 1896.

paticae. Our knowledge of the distribution of species is very much limited. We know next to nothing of the Hepaticae of the entire range of the Rocky Mountains south of northern Idaho, and Mr. Leiberg and others who have sent in considerable quantities of interesting plants from farther north have only shown us the stores of information awaiting the collector in that region. Colorado, Utah, the Sierras from Oregon southward, and all the Southwest from Missouri to Texas, New Mexico and Arizona are a great unknown, no less among all of the lower cryptogams than in the Hepaticae. Much more needs to be done throughout all the States of the Mississippi valley, and especially the southern extension of the Appalachian area, which needs the careful attention of the resident observer, rather than the hasty notes of the transient collector. It is hoped that the above synopsis and descriptions will be sufficient to provide for any student of the group the ready means of identifying his material; we shall be pleased to receive doubtful material, or that illustrating additional facts of distribution.

NEW YORK, 24 September, 1896.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY, COLUMBIA UNIVERSITY.—No. 102.

New and Noteworthy Species of Saxifraga.

By JOHN K. SMALL.

[Reprinted from The Bulletin of the Torrey Botanical Club, Vol. 23, No. 9, Sept. 1896.]

New and noteworthy Species of Saxifraga.

By John K. Small.

Saxifraga occidentalis S. Wats. Proc. Am. Acad. **23**: 264. 1888.

This species was founded on plants collected on Vancouver Island, by Prof. Macoun. It is a beautiful and distinct species averaging one decimeter in height, with a purple hue which extends even to the petals and filaments; it also possesses an abundance of red or reddish tomentum on the lower surface of the finely crenate leaves. This form is not as widely distributed as indicated by Dr. Watson, when he states "the specific name is given to the species as the western correlative of the common eastern *S. Virginiensis*," nor is it the western correlative of the latter species, *Saxifraga Californica*, proposed in the following year holding that place. *Saxifraga occidentalis* is apparently confined to Vancouver Island and the mainland in the immediate vicinity.

Saxifraga Virginiensis Michx. Fl. Bor. Am. **1**: 269. 1803.

Represents one of the most variable and perplexing species of the genus *Saxifraga*, but notwithstanding its variability in habit, size and flowers, there are two characters which serve to separate it from its relatives in western North America, namely, the triangular triangular-ovate or rarely almost lanceolate acute or acutish calyx-segments, and the narrowly elliptic or elliptic-spatulate obtuse or acute (rarely if ever notched) petals.

While collecting in the cañon below the Falls of the Yadkin river in North Carolina last April, I found unusually well developed plants of *Saxifraga Virginiensis* ranging from four to five decimeters in height, but more remarkable was the great quantity of small bulblets produced by the subterranean portions of the plants, and also the numerous offsets. The same features were noticed in specimens gathered on Dunn's mountain in the same state.

SAXIFRAGA CALIFORNICA Greene, Pittonia, 1: 286. 1889.

In the light of recent discoveries, Prof. Greene has not pointed out any reliable distinguishing characters in discussing the relations between *Saxifraga Californica* and *S. Virginiensis.* The two species are closely related in habit, and the one is about as variable as the other. Prof. Greene lays much stress on the occurrence of small bulblets in *Saxifraga Californica*, but we now know that *S. Virginiensis* also possesses this character. After examining many specimens for the purpose of finding some diagnostic characters in the two closely related plants, I find that the flower furnishes the best. Besides the reflexed or erect calyx-segments, these organs in *Saxifraga Californica* are ovate or oblong-ovate and obtuse, while those of *S. Virginiensis* are triangular, triangular-ovate, or rarely nearly lanceolate, and acute or acutish. The petals furnish another character; those of the western plant are broadly oval or suborbicular, some or all notched at the apex, while their lateral nerves vanish in the blade; in the eastern plant they are narrowly elliptic or elliptic-spatulate, not notched at the apex, and the lateral nerves converge to the mid-nerve at the apex.

SAXIFRAGA FRAGOSA Suksdorf n. sp.

Perennial by an ascending or horizontal rootstock, scapose slender, pale-green, rough glandular-pilose with rigid hairs. Leaves basal, leathery, the blades ovate or oblong-ovate, 1.5–4 cm. long, usually exceeding the petioles, glabrate, obtuse, entire or undulately toothed, abruptly narrowed or truncate at the base, decurrent on the winged petiole, which is slightly dilated at the base; scapes erect or assurgent, 2–3 dm. tall, solitary, paniculately or somewhat corymbosely branched at the top, the branches ascending or nearly erect, subtended by lanceolate or spatulate bracts; flowers white, 5–6 mm. broad, in many-flowered cymules; calyx broadly campanulate, the tube 2.5 mm. broad, adnate to the ovary, the segments triangular or triangular-ovate, obtuse, 3-nerved, longer than the tube; petals obovate, obtuse or notched at the apex, 2.5 mm. long, strongly 3-nerved, the lateral nerves arising below the middle and converging toward the apex; filaments subulate, shorter than the petals; carpels of the ovary flat and surrounded by a disk; follicles globose-ovoid, 3.5 mm. long, distinct, tipped by short diverging styles; seeds obovoid, more or less pointed at both ends.

Wet rocks near the Columbia river, W. Klickitat County, Washington. Collected by W. N. Suksdorf. (no. 1727.)

The specimens on which this species is founded were collected in March and May, 1892, and distributed later with the manuscript name which I have taken up. It was collected also in Oregon, by Mr. Thomas Howell in May, 1895, "on wet slopes, Gladstone" (no. 192).

The species is related to *Saxifraga Californica*, but differs in its more rigid habit, rough and stiff pubescence, the narrow thyrsoid panicle or corymb and the triangular or triangular-ovate calyx-segments.

SAXIFRAGA TENNESSEENSIS n. sp.

Saxifraga Grayana Kearney, Bull. Torr. Club, **21**: 262. 1894. Not Britton, 1894.

Perennial by a short erect or ascending rootstock, scapose, glandular-pilose, bright green. Leaves basal, ovate or sometimes suborbicular, the blade 2–6 cm. long, obtuse or rounded at the apex, but usually terminated by a tooth, coarsely crenate-dentate, abruptly narrowed at the base, the petiole winged, longer or shorter than the blade; scapes erect or assurgent, 1–2.5 dm. tall; branches of the panicle subtended by linear or spatulate bracts; cymules open; flowers white, 8–9 mm. broad; calyx flattish, 5 mm. broad, its tube adherent to the ovary, its segments triangular-ovate, 1–1.5 mm. long, acute, spreading, longer than the tube; petals lanceolate, 3.5–4 mm. long, obtuse or slightly notched at the apex, sessile or nearly so, with two lateral nerves which arise below the middle and converge at the apex, the lateral nerves often giving off short secondary branches; filaments subulate, somewhat longer than the calyx-segments, mature fruit not seen.

Rocky bluffs of the Tennessee River about Knoxville. Altitude about 270 meters.

Saxifraga Tennesseensis was apparently first collected by Prof. A. Ruth, of Knoxville, Tennessee, but first brought to notice by

Mr. T. H. Kearney, who erroneously referred it to *Saxifraga Grayana*, a member of the subgenus *Hydactia*. The species really belongs to the subgenus *Micranthes* and is a close relative of the common *Saxifraga Virginiensis*. The primary character to debar it from relationship with *S. Grayana* is its subulate filaments; the calyx-segments, petals and follicles are also different from those of that species. The pubescence in *S. Tennesseensis* is inclined to be tomentose and tawny and is much more abundant than in *S. Virginiensis*. Besides its general habit, it can be readily distinguished by its lanceolate petals, which are notched at the apex and strongly marked with two yellow spots near the base.

SAXIFRAGA CLAYTONIAEFOLIA Canby n. sp.

Perennial by a short horizontal rootstock, slender, glandular-pilose above, glabrate below. Leaves fleshy, orbicular-elliptic, more or less oblique, 6-10 cm. long, glabrate, obtuse, entire, undulate, palmately six-eight-nerved, narrowed into a winged ribbed petiole which is as long as the blade or longer; scape erect or assurgent, 2-3 dm. tall, glabrate near the base, branched above; infloresence thyrsoid-corymbose, its branches subtended by small linear or linear-oblong bracts; flowers white, 4 mm. broad, each subtended by a small bractlet; calyx flattish, 2 mm. high, its segments spreading and recurved, thin, oblong, acute, 3-nerved, longer than the tube; petals spatulate or obovate-spatulate, 2 mm. long, slightly emarginate or minutely apiculate, gradually narrowed into a claw, marked with a stout midnerve which gives off two lateral nerves about the middle; filaments subulate, shorter than the petals, incurved at the summit; follicles (each) ovoid, 3 mm. long, the short stout styles spreading at an angle of 120° or more; seeds irregularly oblong, .7 mm. long, reddish, smooth, or very faintly striate.

Damp crevices of rocks, The Dalles, Oregon. Collected by Frank Tweedy, May, 1883.

I have taken up a specific name attached to a specimen, by Mr. Canby, preserved in the Canby Herbarium, now at the College of Pharmacy, New York. The form is without doubt an excellent species, differing from the related *Saxifraga integrifolia* by its leaves, which closely resemble those of a broad-leaved *Claytonia*, its flat calyx-tube, its oblong calyx-segments and its spatulate or obovate-spatulate petals, which are only 3-nerved and either notched or apiculate at the apex.

SAXIFRAGA NIDIFICA Greene, Erythea, 1: 222. 1893.

This rare *Saxifraga* has lately been sent me by Mr. E. P. Sheldon. The specimens are from Spokane, Washington, altitude 1,000–2,000 feet and were collected by J. H. Sandberg and J. B. Leiberg in May, 1893. *Saxifraga nivalis* (no. 1819) of Mr. Coville's Death Valley report, apparently belongs here, as does also Torrey's 155, collected in the Yosemite Valley and Mountains, California, in 1865.

SAXIFRAGA PLANTAGINEA n. sp.

Perennial by a thick rootstock, stout, scapose, glandular-pilose; leaves elliptic or elliptic-spatulate, 6–10 cm. long, obtuse, undulate or distantly and shallowly toothed, leathery, ciliate, 5-7-ribbed, narrowed into a winged petiole, which is usually much shorter than the blade; scape erect, 2–4 dm. tall, sparingly branched near the top, the branches subtended by elliptic bracts; flowers greenish, in dense cymules; calyx flat, its segments ovate, 3.5 mm. long, obtuse, 3-nerved, longer than the tube; petals suborbicular-oblong or some inclined to be broadly spatulate, 2–2.5 mm. long, greenish, shorter than the calyx-segments, obtuse, marked with a mid-nerve and several branches, narrowed into a broad claw; filaments converging, subulate, shorter than the petals; ovaries immersed in a lobed disk; fruit not seen.

Spokane, Washington, at 600–1,000 meters altitude; collected by J. B. Leiberg and J. H. Sandberg, in May, 1893. Communicated by Mr. E. P. Sheldon.

A fine species with leaves strongly resembling those of some of the broader-leaved *Plantagos*. The plant is very different from anything heretofore known in the genus *Saxifraga*. It is related to *S. integrifolia*. The broad greenish petals, which are exceeded by the calyx, serve to separate the species from all its relatives.

SAXIFRAGA SIERRAE (Coville).

Saxifraga integrifolia Sierrae Coville, Proc. Biol. Soc. Wash. 7: 78. 1892.

Saxifraga Oregana Howell, Erythea, 3: 34. 1895.

As Mr. Howell points out, *Saxifraga integrifolia* has been a composite species. Mr. Coville dwells on the differences in the leaves of *Saxifraga Sierrae* and *S. integrifolia*; these differences are much more marked in specimens collected later by Mr. Howell, in Oregon. But in addition to these leaf-characters, the flower furnishes good points of distinction.

The calyx-segments in *Saxifraga Sierrae* are suborbicular and broader than long (except in Mr. Howell's specimens, where the whole vegetative and floral systems are abnormally elongated), the calyx-segments in *S. integrifolia* are ovate and longer than broad; the petals are ovate or broadly oblong and retuse at the apex, as opposed to the obovate petals of *S. integrifolia* with their rounded apices.

Saxifraga reflexa Hook. Fl. Bor. Am. **1**: 249. pl. 85. 1833.

Several unsuccessful attempts to reëstablish this rare species have been made. Taking Hooker's excellent plate as a basis, and this is all we have to go on besides his description, I find that the following numbers from the collections of the Northern Transcontinental Survey, distributed as *Saxifraga nivalis*, are *S. reflexa*: 51a Scribner, 740 and 741 Tweedy, 757 Brandegee and 111 Canby. These are the only representatives of *S. reflexa* I have seen and are all in the Canby herbarium.

Saxifraga Montanensis n. sp.

Scapose, perennial by a stout horizontal or ascending rootstock, coarse, stout, glandular-pilose. Leaves basal, ovate or lanceolate, .5–1.5 cm. long, leathery, obtuse or acute, serrate-dentate, nearly sessile or apparently sessile on account of the broadly winged and dilated petiole; scapes solitary, erect, 3–6 dm. tall, stout (6–11 mm. in diameter), paniculately branched above, the branches usually shorter than the internodes; flowers greenish, almost 11 mm. broad, in dense glomerate cymules; calyx turbinate-campanulate, 5-parted to below the middle, its tube adnate to the ovary, its segments triangular-ovate, obtuse, at length deflexed; petals 5, greenish, lanceolate or linear, often slightly oblique, 3.5 mm. long, obtuse, 3-nerved, the lateral nerves arising below the middle, running close to the mid-nerve; filaments subulate, thrice shorter than the petals; fruit not seen.

Southwestern Montana, in bogs at 1,850 meters elevation. Collected by Mr. Frank Tweedy (No. 58), July, 1888. Also found by Prof. F. D. Kelsey at Millan, Montana. The proposed species stands between *Saxifraga Sierrae* and *S. Pennsylvanica*. It differs from the former in its harsh pubescence which gives it a dull green color and in its comparatively small greenish flowers. From the latter it may be distinguished by its habit, its more or less turbinate calyx-tube and the calyx-segments, which are triangular-ovate and about as long as the tube. In *Saxifraga Pennsylvanica* the calyx-tube is campanulate, the segments ovate-lanceolate or ovate and twice as long as the tube. The petals of the new species are oblanceolate or nearly linear, while those of its eastern relative are lanceolate or linear-lanceolate.

SAXIFRAGA NOOTKANA Moçin; Engler, Monog. Sax. 135. 1872.

Saxifraga Stellaris var. *Brunnoniana* Bong. Veg. Sitcha, 140. 1831. Not *S. Brunnoniana* Wall.

Saxifraga leucanthemifolia var. *Brunnoniana* Engler, Monog. Sax. 135. 1872.

Saxifraga Bongardi Presl; Engler, Monog. Sax. 135. 1872.

This is one of our northwestern forms that has usually been included under *Saxifraga leucanthemifolia* (*S. Michauxii*). It is more closely related however to the old world *S. stellaris*, but is nearer the Alleghenian *S. Michanxii* than any of the several west-American species of the subgenus *Arabidia* that have so persistently been referred to the Alleghanian form.

SAXIFRAGA FERRUGINEA Graham, Edinb. Philos. Journn. : 349. 1829.

This is another *Arabidia* of the Northwest. It is apparently very rare and has usually been referred to a variety of *S. Michauxii* (*S. leucanthemifolia* Michx.) or included in that species. Some of its distinguishing marks are the low stunted stature, the reddish-brown tomentum and the short few-flowered one-sided corymb. The only recent collection appears to be that of Dr. G. M. Dawson, made on the Queen Charlotte Islands in July, 1878.

SAXIFRAGA NUTTALLII.

Saxifraga elegans Nutt.; T. & G. Fl. N. A. 1: 573. 1840. Not Sternb. 1832.

Little was known of this beautiful and most delicate Saxifrage until it was rediscovered in Oregon in 1871 by E. Hall (156). There is a good and ample specimen of Nuttall's type in the Columbia University Herbarium. Mr. Howell has lately found it at three localities in Oregon.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.

No. 103.

Notes on Potentilla.—IV.

(Plates 274 and 275.)

By P. A. Rydberg.

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Notes on Potentilla.—IV.

BY P. A. RYDBERG.

(Plates 274 and 275.)

The *Aureae* resemble much the *Frigidae* except that the leaves have more than three leaflets. They are all low plants, generally less than 2 cm. high, except *P. dissecta*, which sometimes reaches a height of 3 cm. The pubescence is scant, silky, strigose or hirsute, only in a variety of *P. dissecta* a little tomentose on the lower surface of the leaves, and the plant often becomes glabrous and shining in age. The style in all is very slender and filiform, fastened near the apex of the achene and generally much longer than the achene. Most of the species belonging to this group have truly digitate leaves, but in the North American representatives the outer leaflets are often inserted lower down and the leaves become pinnate with approximate leaflets.

POTENTILLA RUBENS (Crantz) Vill. Prosp. Fl. Dauph. 46. 1779.

P. maculata Pourr. Act. Toloss. 3: 326. 1788.

This species comes very near the *Frigidae*, especially to *P. nana* and *P. Friesiana*. From the latter it differs little except in the number of leaflets. The leaves are much smaller than those of the other American *Aureae*, the leaflets being only 10–20 mm. long. The sepals are broadly ovate, while in the rest they are ovate-lanceolate or lanceolate. *P. rubens* grows in arctic and alpine regions of Europe, in Greenland, the Baffin Bay region and Labrador.

POTENTILLA DISSECTA Pursh, Fl. Am. Sept. 355. 1814.

P. diversifolia Lehm. Nov. Stirp. Pug. 2: 9. 1830.

It would be much better if Lehmann's name were used for this species, as this, without any doubt, belongs to it. As to *P. dissecta* Pursh, nobody seems to know absolutely what it is. Dr. Watson thought it to be the same as *P. diversifolia* Lehm. Lehmann had seen *P. dissecta* in Bank's herbarium, but thought that his *P. diversifolia* was different. Not being able to settle the matter satisfactorily, the author thinks it best for the present not to make a change in the "accepted" nomenclature, although *P. diversifolia* is a good name, and available, and besides has the advantage of belonging to this plant without any doubt.

To the author it seems as if *P. dissecta* rather belonged to *P. multisecta* (see below) or to *P. Ranunculus*. Lange's description and figure of the latter in Flora Danica, and the only specimen seen by me agrees much better with Pursh's description of *P. dissecta* than the present species does.

Dr. Watson included in his *P. dissecta*, with varieties, not less than five different plants, which I believe are all good species, viz.: *P. diversifolia* Lehm, *P. decurrens* (Wats.), *P. multisecta* (Wats.), *P. pinnatisecta* (Wats.) Aven Nelson, and *P. Drummondii* Lehm. These will be discussed further below. He also included *P. rubricaulis* Lehm.; I have not seen any authentic specimens of that. There are two forms that fairly agree with Lehmann's description and figure of *P. rubricaulis*. One differs from *P. diversifolia* Lehm. only in being smaller and with the leaves slightly whitened beneath. Following Gray and Watson, I have taken this to be *P.*

rubricaulis Lehm. and have made it a variety of the present species. I regard the other form as a new species and it will be discussed later.

P. dissecta varies much in the form of the leaves. In the type of *P. diversifolia* Lehm. the lower leaves were pinnate with approximate leaflets, but all the leaves are as often perfectly digitate. The leaflets are larger than in the other related species, oblanceolate, and generally seven in number. In the typical form they are generally appressed-hairy. All specimens seen are from the plain and mountain regions of the West, the range extending from Colorado to California, British Columbia and Saskatchewan.

POTENTILLA DISSECTA GLAUCOPHYLLA (Lehm.) Wats. Proc. Am. Acad. 7: 556. 1873.

P. diversifolia glaucophylla Lehm. Rev. Pot. 73. 1856.

Leaves nearly glabrous, glaucous-green and always digitate.

The range is the same as that of the species, but it is much more common within the United States.

POTENTILLA DISSECTA RUBRICAULIS (Lehm.).

P. rubricaulis Lehm. Nov. Stirp. Pug. 2: 11. 1830.

Leaves somewhat tomentose beneath when young. It may be a hybrid between *P. dissecta* and *P. nivea* or *P. concinna*, as it is rare and only found in the mountains, where these species also grow.

POTENTILLA DECURRENS (Wats.).

P. dissecta decurrens Wats. Proc. Am. Acad. 7: 557. 1873.

This species much resembles the preceding, especially the var. *glaucophylla*, but it is a more cespitose plant and has smaller and thicker leaves with prominent veins beneath. The leaflets are generally five and the lower often attached a little lower down and decurrent on the petioles, but this is not always the case by far. It is found in the higher moutains of Utah, Wyoming and Montana.

Potentilla Ranunculus Lange, Fl. Dan. *pl. 2964*, from Greenland, comes near to both the preceding, differing from both in the more deeply dissected leaves and scaly rootstock. The leaves resemble much those of *P. decurrens*, but are perfectly digitate and much thinner. It seems to be a very rare plant.

Potentilla ranunculoides Humb. & Bonp.; Nestl. Monog. Pot. 56, of Mexico, belongs also to this group, differing from the North American species by its large petals and very broad rounded leaflets.

POTENTILLA MULTISECTA (Wats.).

P. diversifolia multisecta Wats. King's Rep. **5**: 86. 1871.

This was also included in *P. dissecta* by Watson. It is a probability that it is the original *P. dissecta* Pursh, the description of which fits this, as well as *P. Ranunculus* Lange, better than the plant for which the name is used, viz. *P. diversifolia* Lehm. From this, *P. multisecta* differs not only in the finely dissected leaves, but also in the smaller flowers. The leaves are not truly digitate, but the outer leaflets are attached a little lower, as in *P. decurrens*. All are divided into linear divisions. This species therefore connects the *Aureae* with the *Multijugae*, especially with *P. pinnatisecta* and *P. millefolia*. It ranges from Nevada to Montana and Wyoming.

A small group, nearly related to the *Aureae*, especially to *P. decurrens* and *P. multisecta*, but with the leaves more or less tomentulose beneath may be known as the *Subjugae*. The leaves are at the same time digitate and pinnate, *i. e.*, they are digitately 3–5-foliolate with a pair (in the last sometimes 2 pairs) of smaller leaflets further down on the petiole. In this respect they resemble *P. pulchella*, from which the *Subjugae* differ in the style, which is filiform. They are all low and tufted, or cespitose, delicate plants from Colorado, less than 2 dm. high, except the first, which sometimes reaches 3 dm. It approaches in size and habit the *Gracilis* group, *i. e.*, *P. gracilis* and its varieties as understood by Watson. Strangely, all four seem to be undescribed.

POTENTILLA SUBJUGA n. sp.

Tufted from a perennial root; stems many, 1–3 dm. high, silky-villous, few-leaved, rather divergently branched above, the lower portion covered with the brown scarious lower stipules; upper stipules green, ovate, entire. Basal leaves many, digitately 5- (seldom 3-) foliolate with an additional pair of smaller leaflets on the petiole, about 1 cm. below the others; leaflets 1–4 cm. long, oblong or obovate, deeply incised into oblong rather obtuse segments, silky and green above, silky and white-tomentose beneath; stem-leaves generally ternate, few and reduced in size; calyx silky-hirsute, in fruit 5–8 mm. in diameter; bractlets oblong, obtuse or acute, about ⅓ shorter than the ovate triangular acuminate sepals; petals broadly obcordate exceeding the sepals; stamens about 20; style filiform, nearly terminal; achenes smooth. (Plate 274.)

As before noted it resembles somewhat the species of the *Gracilis* group, especially *P. fastigiata* in size and *P. pulcherrima* in the form of the leaflets and the pubescence. The latter has digitate or more or less pinnate leaves with approximate leaflets, but they are never, as in *P. subjuga*, digitately 5-foliolate with a pair of smaller ones some distance below. In *P. subjuga*, the leaflets are more deeply incised and the stem and branches stricter and the latter rather divergent; they are few-flowered,* as in *P. nivea*, from which it differs in the number of the leaflets.

Colorado: N. H. Patterson, no. 192, 1892 (from near Empire, type); 1885 (from Gray's Peak); C. S. Crandall, no. 184, 1892 (from Graymont); T. C. Porter, no. 44; Hall and Harbour, no. 160, 1862, mainly.

POTENTILLA TENERRIMA n. sp.

Tufted from a perennial root; stems many, very slender, generally tinged with red, 1–1½ dm. high, sparingly strigose; stipules linear, lanceolate, acuminate, about 1 cm. long, the lower scarious and brown. Leaves digitately 3-foliolate, with a pair of smaller leaflets below, or, which is the same, pinnate of 2 pairs and terminal leaflet sessile, finely silky and a little grayish tomentulose beneath; leaflets obovate or oblanceolate in outline, divided to near the midrib into linear acute segments; flowers on slender pedicels, nearly 1 cm. in diameter; calyx silky-strigose, in fruit ½ cm. in diameter; bractlets linear, acute, very little shorter than the narrowly lanceolate sepals; petals obovate, slightly retuse, a little exceeding the sepals; stamens about 20; style filiform, nearly terminal; achenes smooth. (Plate 275, figs. 1–5).

It resembles a very slender form of the preceding, but the terminal leaflets, as in the two next, are always only three. The segments of the leaflets are also much narrower, as also the bracts and sepals, which are narrower than in any other North American species.

Colorado: Brandegee, no. 950, 1874 (from Bergen's Park, type); Hall and Harbour, no. 160 (in part, in the Harvard herbarium).

* *P. rubricaulis* Lehm. may perhaps be a form of this with only 3 terminal leaflets and more erect branches.

Potentilla minutifolia n. sp.

Cespitose, stems about 1 dm. long, slender, 1–2-leaved, sparingly silky or nearly glabrous, slightly striate; stipules ovate-lanceolate, the lower scarious and brown; basal leaves very small, on slender petioles 3–5 cm. long, silky-hirsute, slightly grayish beneath, pinnate, of two pairs of leaflets, the upper pair and the sessile odd leaflet about 1/2 cm. long; the lower pair only 2–3 mm.; leaflets obovate, incised, with oval rounded segments; flowers 1–2, about 15 mm. in diameter; calyx sparingly hirsute, in fruit 7–8 mm. in diameter; bractlets oblong, generally obtuse, about half as long as the oblong-lanceolate obtuse or acutish sepals; petals obcordate, about 1/2 longer than the sepals. (Plate 275, figs. 6–10.)

This somewhat resembles *P. subjuga*, but differs in the small size of the plant and of the leaves, the three terminal leaflets, and their short and rounded segments.

Colorado: Wm. M. Canby (Pikes Peak) 1895.

Potentilla saximontana n. sp.

Densely cespitose; stems several, 1–3-flowered, less than 5 cm. long, silky pubescent. Basal leaves numerous, pinnate with 2–3 often approximate pairs of leaflets, silky pubescent and somewhat tomentose beneath, short-petioled; leaflets deeply dissected into oblong obtuse or acute segments; flowers about 1 cm. in diameter; calyx densely silky; bractlets oblong, obtuse, shorter than the broadly ovate-triangular sepals; petals broadly obcordate, much longer than the sepals; stamens about 20; style nearly terminal, about equalling the smooth achene.*

It somewhat resembles the preceding, but is still more cespitose, has much broader sepals and larger leaves, which have much shorter petioles. The leaves resemble somewhat those of *P. pinnatisecta* (Wats.) Aven Nelson (*P. ovina* Macoun), but are slightly tomentose. The flowers are much larger and the sepals much broader than in that species. It resembles also somewhat *P. Sommerfeltii*, but has much more dissected leaves, and the style is different. The following specimens have been examined:

Colorado: John Wolf, no. 366, 1873 (Wheeler's expedition, type); Hooker & Gray, 177 (Torrey's Peak); Knowlton, no. 19, 1896 (Pike's Peak).

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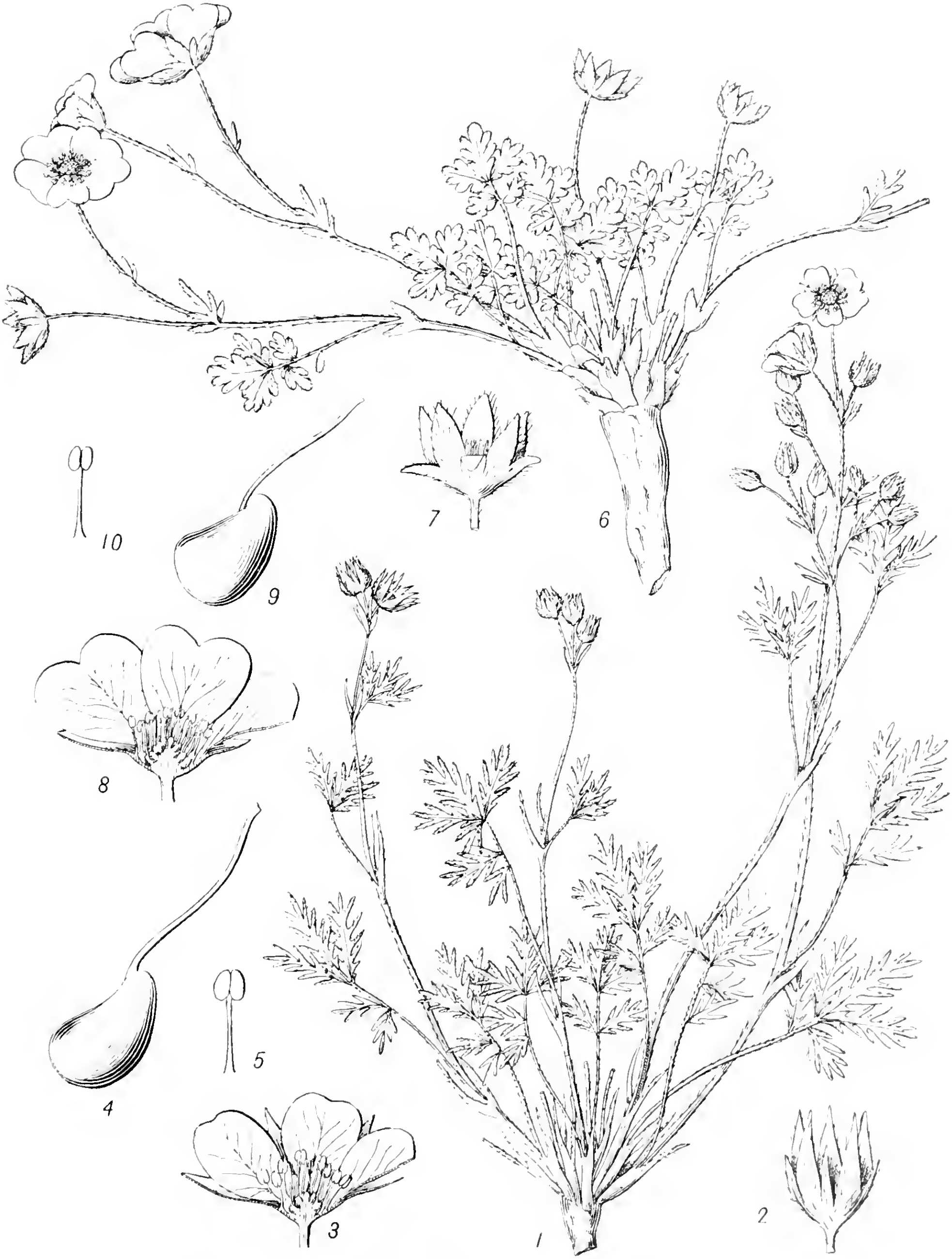
* The plate of this will appear in a subsequent number.

POTENTILLA SUBJUGA RYDB.



1-5 POTENTILLA TENERRIMA RYDB. 6-10 P. MINUTIFOLIA RYDB.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.

No. 104.

Studies in the Botany of the southeastern United States—VII.

By JOHN K. SMALL.

[Reprinted from THE BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 23, No. 10, Oct. 1896.]

Studies in the Botany of the southeastern United States—VII.

By John K. Small.

Rumex Langloisii n. sp.

Perennial, glabrous, somewhat scurfy, dark green (when dry). Stem erect or ascending, 5–7 dm. tall, simple or with a few nearly erect branches, more or less flexuous, at length strongly furrowed; leaves oblong or linear-oblong, 3–12 cm. long, acuminate or acutish, erose crenulate, slightly crisped, somewhat prominently nerved especially beneath, narrowed into a petiole which is usually 1 or 2 cm. long; ocreae very thin, early falling away; panicle rather open, not leafy, 1–2 dm. long; racemes strongly ascending, 5–10 cm. long, usually interrupted; flowers about 2 mm. long, in dense whorls (in fruit); pedicels about 5 mm. long, articulated near the base, enlarged towards the end; wings rather coriaceous, deltoid, 4 mm. long, the sides rounded, the apex blunt, the surface prominently nerved, each bearing a papillose calosity 1 mm. broad and 3 mm. long; achene ovoid, nearly 3 mm. long, abruptly contracted into a very short base, slightly acuminate at the apex, the faces dark red, the angles slightly paler and margined.

Southern Louisiana, New Orleans (Joor, according to Trelease, and Pointe a la Hache (Langlois).

This is *Rumex Floridanus* Trelease, but not *R. Floridanus* Meisner. With the original specimens of *R. Floridanus* Meisner at hand I cannot separate them from *R. verticillatus*, to which Meisner says the species is closely related. Prof. Trelease has given the plant its correct position, but referred it to the wrong species. *R. Langloisii* is intermediate between *R. verticillatus* and *R. altissimus* in these respects: its inflorescence suggests the latter, while its foliage suggests that of the former.

POLYGONELLA Michx. Fl. Bor. Am. 2: 240. 1803.

[LYONIA Raf. Med. Repos. N. Y. 5: 352. 1808.]
[STOPINACA Raf. Fl. Tellur. 3: 11. 1836.]
[GONOPYRUM F. & M.; C. A. Meyer, Mem. Acad. St. Petersb. (VI.) 4: 144. 1840.]

Key to the Species.

Flowers polygamo-dioecious; filaments subulate or filiform, nearly alike or some slightly dilated at base; embryo axial
- Ocreae fringed with a few bristle-like cilia. — 1. *P. ciliata.*
- Ocreae naked.
  - Leaves 1–5 mm. broad.
    - Achenes rhomboidal; leaves filiform-subulate. — 2. *P. brachystachya.*
    - Achenes ovoid or oblong-ovoid; leaves wedge-shaped or spatulate.
      - Stems branched above; outer calyx-segments not reflexed. — 3. *P. gracilis.*
      - Stems diffusely branched at the base; outer calyx-segments reflexed. — 4. *P. polygama.*
  - Leaves 5–25 mm. broad. — 5. *P. macrophylla.*

Flowers perfect; filaments dissimilar, the inner conspicuously dilated; embryo near one of the faces of the endosperm.
- Annual; outer calyx-segments not reflexed, the inner not becoming conspicuously larger than the outer. — 6. *P. articulata.*
- Perrennial; outer calyx-segments reflexed; the inner developing large wings. — 7. *P. Americana.*

1. POLYGONELLA CILIATA Meisn. in DC. Prodr. 14: 81. 1856.

Vicinity of the Manatee river, Florida.

As late as the year 1894 there seems to have been only one collection of the above species; this was Rugel's 429, on which

Meisner based the species. In August, 1895, Mr. Nash collected specimens at Palmetto, Manatee county, Florida (no. 2429). This second station is in the vicinity of the original station. The geographic range of *Polygonella ciliata* seems to be very restricted.

2. POLYGONELLA BRACHYSTACHYA Meisn. in DC. Prodr. **14**: 80. 1856.

Polygonella Croomii Chapm. Fl. S. States, 387. 1860.

As far as I can see, these two species must be united. Having the types of both at hand I cannot find any distinctive characters and in addition the labels show that *Polygonella Croomii* is from "South Florida," and not from "Carolina or Georgia," as Dr. Chapman records in the Flora of the Southern United States.

3. POLYGONELLA GRACILIS (Nutt.) Meisn. in DC. Prodr. **14**: 80. 1856.

Polygonum gracile Nutt. Gen. **1**: 256. 1818.

Polygonum setaceum Nutt.; Meisn. in DC. Prodr. **14**: 80. 1856.

Sand hills, South Carolina to Florida and Louisiana.

4. POLYGONELLA POLYGAMA (Vent.) A. Gray, Bost. Journ. Nat. Hist. **5**: 231. 1847.

Polygonum polygamum Vent. Hort. Cels, *pl. 65*. 1800.

Polygonella parviflora Michx. Fl. Bor. Am. **2**: 241. 1803.

Atraphaxis dioica Bosc; Meisn. in DC. Prodr. **14**: 80. 1856.

Polygonella parvifolia var. *subenervis* Meisn. in DC. Prodr. **14**: 80. 1856.

Dry, sandy soil near the coast, from North Carolina to Florida.

5. POLYGONELLA MACROPHYLLA n. sp.

Perennial (?), stoutish, glaucous, glabrous. Stem solitary, erect, 8 dm. tall, simple below, branched above; leaves obovate or oblanceolate, 2–6 cm. long (sometimes shorter on the branchlets), obtuse, 3–5-nerved, leathery, exceeding the internodes except on the upper part of the stem; ocreae cylindric, slightly oblique, not pointed, increasing in length toward the upper part of the stem; racemes very dense, 2–3 cm. long, disposed in ovoid panicles; ocreolae funnelform, densely imbricated, slightly pointed; pedicels jointed at the middle; calyx (flowering stage not seen), the outer segments slightly accrescent, the inner developing wings; filaments subulate, somewhat dilated at the base; style 3-parted to the base; wings oblong, 4 mm. long; achene 3-angled, narrowly oblong, acuminate at both ends, 4 mm. long, brown.

"Sandhills near the coast, Florida, A. W. Chapman."

Strikingly different from anything heretofore described in the genus but related to *Polygonella polygama*. It differs from all its relatives in its stout build, wand-like stem and remarkably large leaves for the genus.

6. POLYGONELLA ARTICULATA (L.) Meisn. Gen. **2**: 228. 1836–43.

Polygonum articulatum L. Sp. Pl. 363. 1753.

Sandy beaches along the Atlantic coast from Maine to Florida and along the Great Lakes.

7. POLYGONELLA AMERICANA (F. & M.) Small, Mem. Torr. Club, **5**: 141. 1894.

Gonopyrum Americanum F. & M. Mem. Acad. St. Petersb. (VI.) **4**: 144. 1840.

Polygonella ericoides Engelm. & Gray, Bost. Journ. Nat. Hist. **5**: 230. 1847.

Polygonella Meisneriana Shuttlw.; Meisn. in DC. Prodr. **14**: 81. 1856.

Sandy soil, Missouri to Georgia, south to Alabama and Texas.

With the two excellent specimens from which Meisner drew his original description, to compare with a generous supply of *Polygonella Americana* and observations in the field, I cannot separate *Polygonella Meisneriana* from *P. Americana*. There may be two species in what is now included in the latter species, but the separation must be on different lines.

THE GENUS WAREA.

I have always been impressed with the remarkably inconsistent descriptions that have been applied to the plant we have known as *Warea amplexifolia*. The discovery, by Mr. Nash, of a third species of *Warea* in western Florida renewed my interest in the group and led me to investigate it. The facts seem to be as follows: In 1822 Nuttall described *Stanleya? amplexifolia*,* founding the species on a specimen from eastern Florida. This plant had amplexicaul leaves. In 1834 Nuttall founded the genus

* Am. Journ. Sci. **5**: 297.

Warea,* making the type a *Warea amplexifolia* founded on a plant from western Florida. This plant had sessile leaves, according to the author and his plate. Nuttall was not as shrewd as usual, and failing to see that his *Warea amplexifolia* was different from *Stanleya amplexifolia*, combined the original description of *Stanleya amplexifolia* with that of *Warea amplexifolia*; this blunder has been followed to the present day and consequently the ambiguous descriptions.

The plant from eastern Florida has been represented in our herbaria by good and ample specimens while only a few fragments of the west Florida plant seem to be extant, but now that we are furnished with excellent material the specific lines appear very distinct. I append a synopsis of the genus.

WAREA Nutt. Journ. Acad. Phila. 7: 83. *pl. 10.* 1834.

Key to the Species.

Leaves narrowly cuneate at the base; claws of the petals pectinate-fimbriate. 1. *W. cuneifolia.*

Leaves rounded or auricled at the base.

Leaves sessile, not auricled at the base; claws of the petals gran lar-toothed. 2. *W. sessilifolia.*

Leaves clasping, auricled at the base; claws of the petals serrulate. 3. *W. amplexifolia.*

1. WAREA CUNEIFOLIA (Muhl.) Nutt. Journ. Acad. Phila. 7: 84. 1824.

Cleome cuneifolia Muhl. Cat. 61. 1813.

Stanleya gracilis DC. Syst. 2: 512. 1821.

Cleome laevigata Soland.; DC. Syst. 2: 512. As synonym. 1821.

Sand hills, Georgia to Florida, near the coast.

2. WAREA SESSILIFOLIA Nash, Bull. Torr. Club. 23: 101. 1896.

Warea amplexifolia Nutt. Journ. Acad. Phila. 7: 83. *pl. 10.* 1834. Not *Stanleya amplexifolia* Nutt.

Sandhills, West Florida at about 100 feet above sea-level.

3. WAREA AMPLEXIFOLIA (Nutt.)

Stanleya amplexifolia Nutt. Am. Journ. Sci. 5: 297. 1822.

Sand hills, East Florida, near sea-level.

CARDAMINE ARENICOLA Britton, Bull. Torr. Club, 19: 220. 1892.

This has been found by Prof. Scribner growing in sand and

* Journ. Acad. Phila., 7: 83. *pl. 10.*

shaly soil about Knoxville, Tennessee. It is also plentiful in the sandy summit of Little Stone Mountain, Georgia.

EUPHORBIA HUMISTRATA Engelm.; A. Gray, Man. Ed. 2. 386. 1856.

The known geographic ranges of the above species has lately been greatly extended southward by collections from Mississippi Professors. Tracy and Earle found it on Horn Island (2886) and at Biloxi (2913).

The name *Gatesia* cannot be applied to the Acanthaceous genus of the southern United States, with which it has lately been associated, having previously been used for an entirely different plant. I take pleasure in using in this connection the name of Prof. W. S. Yeates, State Geologist of Georgia, for while on his survey I first met this rare and peculiar species along the Flint river, in southwestern Georgia. Previously it had not been known to occur east of Alabama.

YEATESIA.

[GATESIA A. Gray. Proc. Am. Acad. **13**: 365. 1878. Not Bertol. 1848.]

YEATESIA LAETE-VIRENS (Buckl.).

Justicia laete-virens Buckl. Am. Journ. Sci. **45**: 176. 1843.

Rhytiglossa viridiflora Nees, in DC. Prodr. **11**: 346. 1847.

Dicliptera Halei Ridd. New Orleans Med. Journ. 1852.

Gatesia laete-virens A. Gray, Proc. Am. Acad. **13**: 365. 1878.

Justicia viridifolia Buckl.; Nees in DC. Prodr. **11**: 346. As synonym. 1847.

Tennessee to Georgia, Florida and eastern Texas.

VIBURNUM RUFOTOMENTOSUM.

Viburnum prunifolium var. *ferrugineum* T. & G. Fl. N. A. **2**: 15. 1841.

Viburnum ferrugineum Small, Mem. Torr. Club, **4**: 123. *pl. 78.* 1894. Not Raf. 1838.

Viburnum prunifolium is said to grow as far south as Mississippi and Florida, but during all my travels in the Southeast I have not met with the species. *Viburnum rufotomentosum* seems to replace our common plum-leaved *Viburnum* in the Southern States. The most southern station at which I have collected *V. prunifolium* is Salisbury, North Carolina.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 105.

Notes on Potentilla.—V.

By P. A. RYDBERG.

[Reprinted from The Bulletin of the Torrey Botanical Club, Vol 23, No. 11, Nov. 1896].

Notes on Potentilla.—V.

By P. A. Rydberg.

(Plates 276, 277.)

The *Subviscosae* is a small group of low plants with many more or less spreading branches from the caudex, with a silky or hirsute pubescence, often intermixed with almost sessile glands, but not at all tomentose; with digitate leaves of 5–7 leaflets, and in fruit, with incurved sepals which enclose the large, but comparatively few achenes. The petals are more or less contracted at the base, *i. e.*, semi-unguiculate, although indistinctly so in *P. Wheeleri*.

Potentilla Wheeleri Wats. Proc. Am. Acad. **11**: 148. 1876.

The pubescence is quite densely silky, and the typical form is apparently without glands. The leaflets are obovate and crenate at the rounded summit, 1–1.5 cm. long. The petals are obcordate, slightly contracted at the base, and a little exceed the calyx. It has been collected in southern California, Arizona and northern Mexico. A form connecting it with the next may be regarded as a variety or perhaps as a distinct species. It may be known for the present as

Potentilla Wheeleri viscidula n. v.

Subcaespitose, rather hirsute with spreading hairs, somewhat glandular-granuliferous on the calyx, pedicel, etc.; leaflets shorter and broader, generally less than 1 cm. long.

The following specimens have been seen:

Arizona: C. G. Pringle, 1881; J. G. Lemmon, no. 158. 1881.

California: W. G. Wright, 1879; Coville & Funston, no. 1672. 1891.

Pringle labelled his specimens *Potentilla subviscosa* Greene (near *P. Wheeleri* Wats.). I think, however, that it should be referred to *P. Wheeleri* rather than to *P. subviscosa*, as it does not have the dissected leaves and the subunguiculate petals of *P. subviscosa*.

POTENTILLA SUBVISCOSA Greene, Bull. Torr. Bot. Club, **8**: 97. 1881.

Differs from *P. Wheeleri* in the leaflets, which are deeply cleft into oblong divisions, and the middle one often 3-divided to near the midrib, in the petals which are more or less plainly unguiculate and about one-half longer than the sepals, in the more hirsute pubescence which is intermixed with numerous glands. It resembles closely the figure of *P. Dombeyi* in Nestler's Monograph, but neither Nestler nor Lehmann mention anything concerning the glands or the unguiculate petals. *P. Dombeyi* was described from specimens from Chili, but has been reported from Mexico. I have not seen any specimens and doubt its existence there. *P. subviscosa* grows in Arizona and New Mexico.

POTENTILLA RAMULOSA n. sp.

Stems several from the thick perennial root, about 1 dm. high, scarcely exceeding the basal leaves, more or less hirsute, and branched. Stipules lanceolate, the lower scarious and brown, the upper herbaceous; basal leaves on hirsute petioles 5–8 cm. long, finely pubescent, in age shining; leaflets 5–7, obovate, coarsely and generally doubly toothed with somewhat divergent teeth, prominently veined beneath, the larger 5–7 cm. long. Flowers slender-pediceled in an open cyme; calyx and pedicels hirsute and with numerous sessile glands; bracts oblong, a little shorter than the oblong-ovate sepals; both distinctly veined, in fruit incurved and inclosing the rather few large achenes; petals obcordate, deeply emarginate and evidently contracted in a short claw; stamens 15–20; pistils rather few; achenes striate. (Plate 276.)

P. ramulosa resembles *P. subviscosa*, but is a much larger plant. The leaves, by their size, pubescence and form, remind one somewhat of *P. Nuttallii* and *P. Blaskeana*. The leaflets reach a length of even 7 cm. The general habit, form of calyx and corolla, etc., are those of *P. subviscosa*, but the achenes are striate. The follow ing specimens have been examined:

Arizona: J. G. Lemmon, no. 399, 1881; H. H. Rusby, 1883.

The *Concinnae* have the same relationship to the *Niveae* as the *Aureae* have to the *Frigidae*, *i. e.*, they are *Niveae* with more than three leaflets. From the *Subviscosae* they differ by the tomentum on at least the lower surface of the leaves, and by their petals, which are not at all unguiculate.

POTENTILLA CONCINNA Richardson, Frank. Journ. 736. 1823.

P. concinna resembles *P. nivea* in many respects, especially the variety *quinquefolia*, but is always more or less prostrate, and has broader petals and sepals. It is very variable as to the shape of the leaves. In the typical form the leaflets are obovate or cuneate and crenate, and slightly tomentose also on the upper surface. It ranges from Colorado to Utah and Saskatchewan.

Potentilla concinna humistrata Rydberg, Cont. U. S. Nat. Herb. 3: 497 (*P. concinna humifusa* Lehm. Rev. Pot. 112. *P. humifusa* Nutt. Gen. 1: 310.) is a less spreading form with leaves that are green on the upper surface, but the two forms grade into each other in so many ways that it is useless to try to draw a line between them.

P. CONCINNA DIVISA n. v.

P. nivea dissecta S. Wats. Proc. Am. Acad. 7: 556, at least in part. 1873. Not *P. dissecta* Pursh, 1814.

Leaflets pinnately divided. In a few cases the leaves are also pinnate rather than palmate.

Dr. Watson included the three first specimens cited below in his *P. nivea dissecta*, but in every respect they are much nearer *P. concinna* than *P. nivea*, the sepals, petals and general habit being exactly that of the former.

Rocky Mountains: Douglas.

Montana: Howard.

South Dakota: Jenney. 1875; W. H. Forwood, 1887; P. A. Rydberg, nos. 672 and 673. 1892.

Assiniboia: John Macoun, no. 10,468, 1895.

POTENTILLA BICRENATA n. sp.

Low and simple from an erect scaly rootstock; stem erect, 5–7 cm. high, about equalling the leaves, 1–3-flowered, nearly leafless; basal leaves on petioles 3–6 cm. long, digitately 5-foliolate, silky and greenish above, white-tomentose beneath; leaflets ½–2 cm. long, oblong-cuneate, margins entire, except at the very apex, where there are 2 (seldom 4) notches making the leaflet 3- (seldom 5-) toothed at the apex, the middle tooth generally the smallest; flowers about 1 cm. in diameter; calyx silky; bractlets and sepals ovate or lance-ovate, the former smaller; petals obovate, merely truncate.

It much resembles the preceding, but is more delicate, not at all spreading, has a subscapiform stem and smaller flowers, but the most striking difference is the form of the leaflets.

New Mexico: C. D. Walcott, no. 66, 1883 (Type).

Colorado: E. L. Greene, 1875.

The *Multijugae* is a group of Potentillas in many respects reminding us of the *Multifidae*. The leaves in both are pinnate with several leaflets, but the pinnae in the present group are generally much more numerous; the pubescence is hirsute, strigose or silky, always without any indication of tomentum, and the style is always long and filiform. To this group belong *P. Richardii* Lehm., from Mexico, differing from *P. Plattensis* mainly in the spreading pubescence, and the following North American species:

POTENTILLA PLATTENSIS Nutt.; Torr. & Gray, Fl. N. Am. 1: 439. 1840.

The type specimens of Nuttall have light green leaves with 4–8 pairs of oblong-cuneate leaflets, dissected into broadly oblong obtuse segments ½ cm. long, and a stem that is more or less ascending. In the more common form, however, the segments are often ¾ cm. long, nearly linear and often acute, the stem more or less spreading and the flower-clusters very irregular. It may be a good variety.

All forms of *P. Plattensis* are characterized by the stipules, which are unusually large for the size of the plant. Its range is from Colorado and Utah to the Saskatchewan, but it belongs to the valleys of the high plains rather than to the alpine regions.

POTENTILLA PINNATISECTA (Wats.) Aven Nelson, Bull. Wy. Exp. St. 28: 104. 1896.

P. diversifolia pinnatisecta Wats. King's Rep. **5**: 87 (in part), 1871.

P. ovina James Macoun, Can. Rec. Sci.

The specimens from which *P. diversifolia pinnatisecta* were described, viz: Watson's nos. 331 and 332 of the King Expedition illustrate, I think, not less than three different species. In the Gray Herbarium, no. 331 is represented as it seems by a typical *P. Plattensis*. This is doubtless the reason why Watson afterwards transferred the var. *pinnatisecta* to that species. No. 332, which Watson, in King's Report, characterizes as an alpine more hairy form, is there represented by a specimen of what James Macoun describes as *P. ovina*. This may be regarded as the typical *P. pinnatisecta*, as the other forms of the collection are already named. In the Columbia Herbarium, no. 331 is represented by an unusually large form of *P. pinnatisecta* (*P. ovina* Macoun) and no. 332 by a depauperate specimen of *P. Breweri expansa* Wats.

The main differences between *P. Plattensis* and *P. pinnatisecta* are well pointed out by Prof. Nelson, *l. c.*, only that his characterizing of *P. Plattensis* refers rather to the most common, more prostrate form with narrow segments, mentioned above, and that his specimens representing *P. pinnatisecta* are unusually large, less hairy and with longer segments than usual. The typical form is subcaespitose, seldom over 1 dm. high, with nearly leafless flowering stems, smaller stipules than in *P. Plattensis*, and a densely hoary pubescence, especially when young. It ranges from Colorado and Utah to British America, and is a strictly alpine plant.

Potentilla millefolia n. sp.

Low, prostrate or spreading; stems numerous from the caudex, about 1 dm. long, few-leaved, only a little exceeding the basal leaves, appressed-strigose, often sparingly so. Lower stipules lanceolate and scarious and brown, the upper ovate-lanceolate, acute or acuminate, green, often 2–3 cleft. Basal leaves pinnate, of many pairs, sparingly strigose-ciliate, nearly as long as the stems; stem-leaves much reduced. Leaflets divided nearly to the base into linear subulate divisions, which therefore look as if verticillate. Pedicels slender, 1–2 cm. long, in fruit abruptly reflexed below the strigose-hirsute calyx. Bractlets and sepals lanceolate, acute, the former slightly smaller. Corolla 12–18 mm. in diameter. Petals obcordate, deeply notched, longer than the sepals. Stamens about 20. Achene smooth, with a slender filiform nearly terminal style. (Plate 277, figs. 1–5.)

P. millefolia most resembles *P. Plattensis*, but differs in the long and very narrow segments of the leaves, the reflexed fruiting calyx and the longer sepals. The following specimens have been examined:

California: J. G. Lemmon, 1873, 1874, and no. 86, 1875 (Type); E. L. Greene, no. 750, 1876; J. W. Congdon, no. 277, 1880.

POTENTILLA MULTIJUGA Lehm. Rev. Pot. 29, 1856.

This species has been lost for about 40 years. As in the collections of this country there were no specimens of a *Potentilla* whose leaves resembled those of Lehmann's plate, and as those of the latter resembled the leaves of *Horkelia cuneata*, most botanists have cited *P. multijuga* as a synonym of that species, and even Professor Greene, in Flora Fransiscana, has adopted the name. It is not very likely that such an acute observer and eminent botanist as Dr. Lehmann would have figured a *Horkelia* with true *Potentilla* flowers. In two collections, viz., those of the National Herbarium and the herbarium of Harvard University, I have found a *Potentilla* that answers Lehmann's description and plate, except that the plant is more rank and the leaflets are larger, more irregular in form and position.

P. multijuga resembles much *P. Plattensis*, but the leaflets are more numerous, 8–13 pairs, obovate-cuneate and toothed only toward the apex, and the sepals broader ovate and abruptly contracted at the apex. The leaflets in Lehmann's figure are about 2 cm. long; some in the latter specimens are nearly ½ decimeter. Lehmann's figure illustrates an undeveloped specimen about 2½ dm. high. Some of the better developed specimens are ¾ m. high, with leaves 3 dm. long.

POTENTILLA DRUMMONDII Lehm. Nov. Stirp. Pug. 2 : 9. 1830.

Watson included this in *P. dissecta*. As he had only comparatively poor specimens, with few, more approximate leaflets, it was not strange that he did so, especially with his tendency of uniting forms somewhat related. Had he had such specimens as those collected by Suksdorf, or the one from which Lehmann's figure was drawn, I doubt if he had done it. Such well-developed specimens have pinnate leaves of 3–5 rather distant pairs of leaflets, very large stipules resembling those of *P. Plattensis* and a large calyx which is strongly hirsute. From *P. Plattensis* and the other species of the group it differs in the stoutness of the plant, which is 3–6 dm. high and by the fewer (2–5 pairs) and larger leaflets, which are from 3–6 cm. long, and the acute teeth. It is a rare species. The only specimens seen are the following:

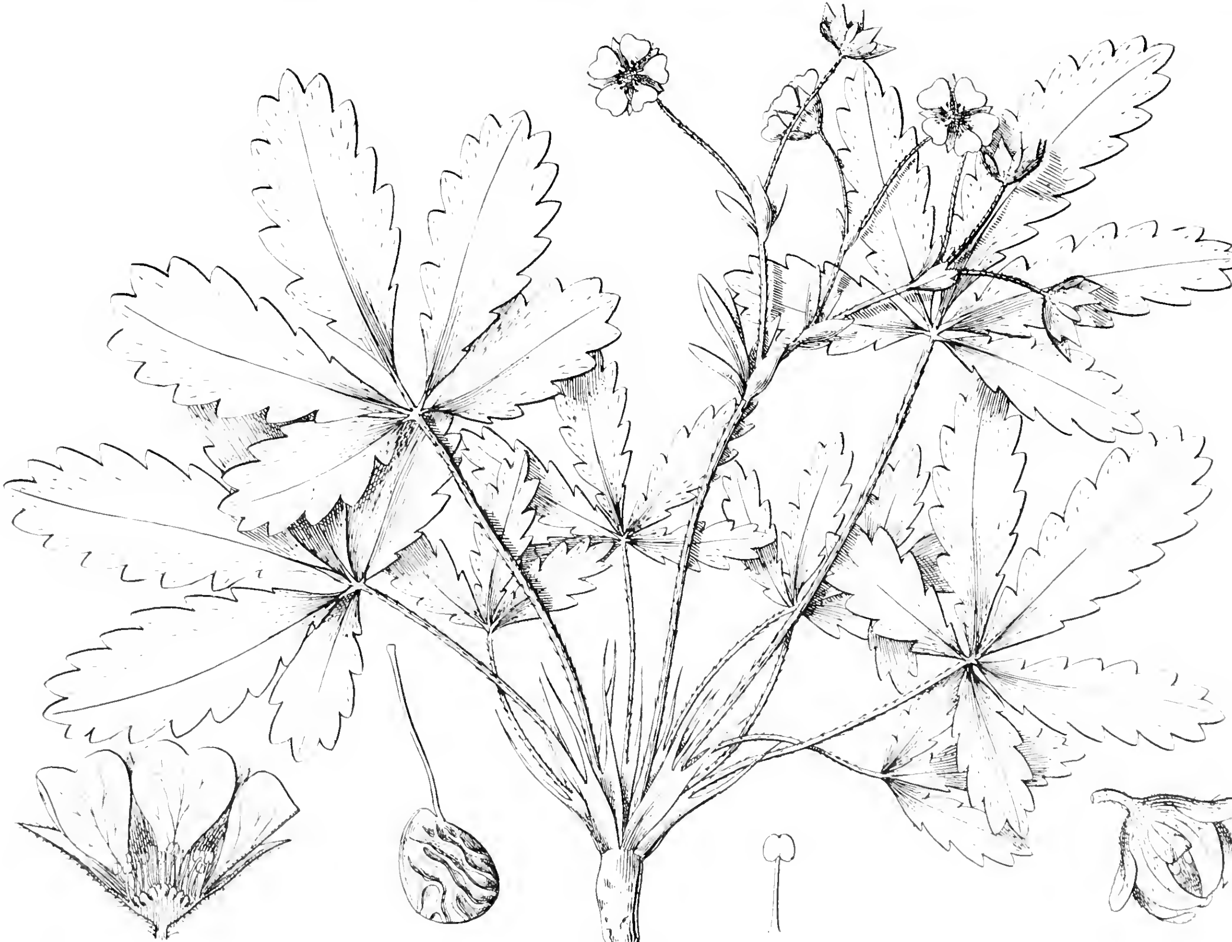
Washington: W. N. Suksdorf, no. 539. 1875.

Oregon: Elihu Hall, no. 135. 1871.

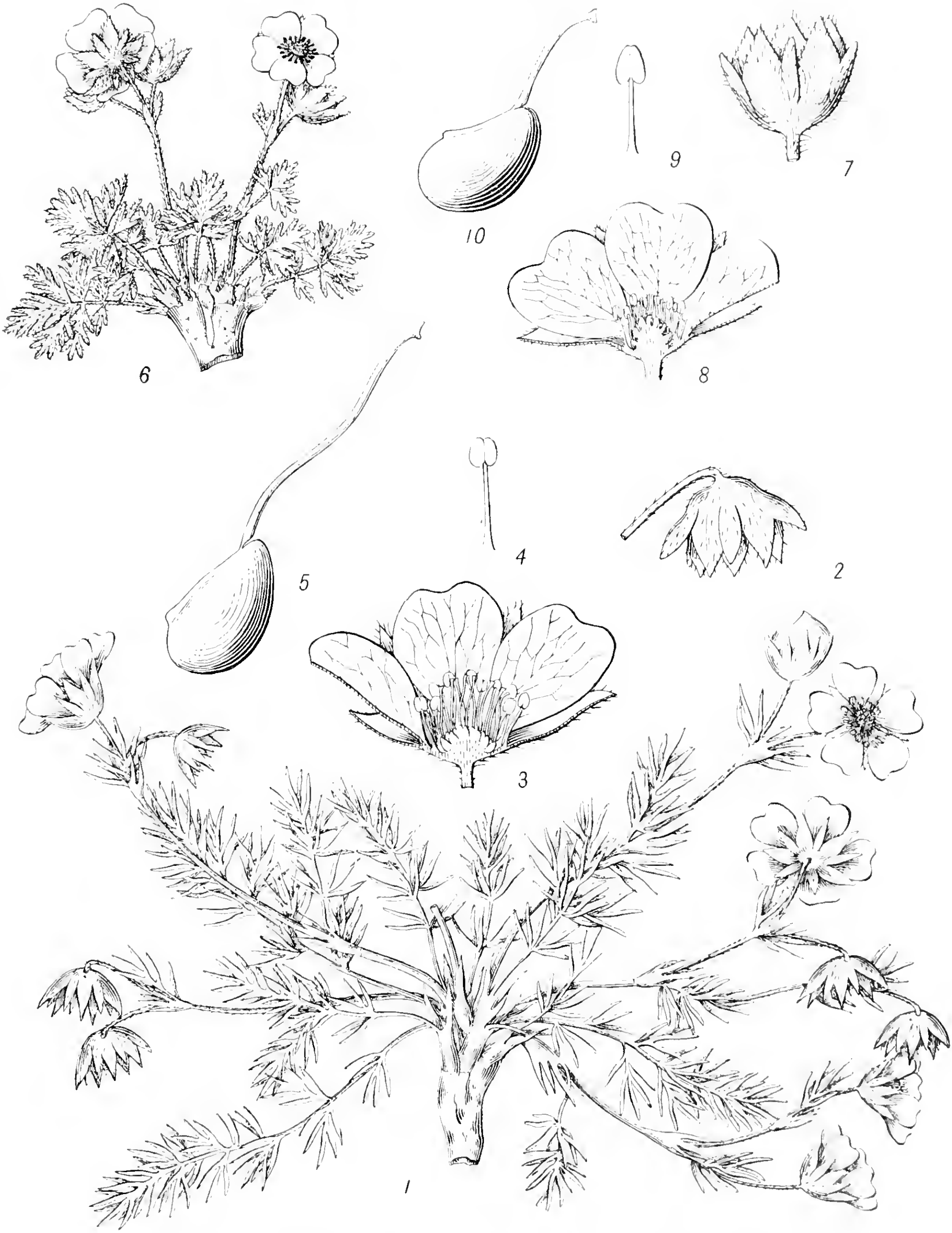
California: J. G. Lemmon, no. 1200. 1875.

British Columbia: John Macoun, no. 32. 1890.

Rocky Mountains of British America: E. Bourgeau, 1858.



POTENTILLA RAMULOSA RYDBERG.



1–5. POTENTILLA MILLEFOLIA RYDB. 6–10. P. SAXIMONTANA RYDB.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 106.

Reinke's Discussions of Lichenology.

By ALBERT SCHNEIDER.

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Reinke's Discussions of Lichenology.

By Albert Schneider.

It is thought advisable to give a review of Reinke's paper on lichenology, because this author is doubtless the most competent advocate of modern scientific lichenology. Although much of the author's discussion is based upon theory and the observations of others, yet the papers are of inestimable value to the special student, and we hope that they will be collected and issued in book form. Meanwhile it is hoped that this review may be found useful by those English-speaking students who can not readily avail themselves of the original communications.

I.

The Podetium of Cladonia.*

This paper is in reality a criticism of Krabbe's† monograph of the genus *Cladonia*. Krabbe maintains that the podetia belong to and are a part of the spore-bearing organs (apothecia). His conclusions are based upon the observation of the morphological characters and the mode of development which, according to Reinke and other modern biologists, are not sufficient. Nor can the morphological characters or structure be deduced from its development. Krabbe assumes that since the podetia of *Cladonia* originate in a manner similar to the apothecia of *Ramalina*, *Parmelia*, *Lecanora*, etc., they must be apothecial structures The entire discussion depends upon the points of view. Krabbe, having considered the podetia from the morphological and developmental point of view, naturally comes to different conclusions from Reinke, who views the same structures from the physiological standpoint. It is an excellent example illustrating the necessity of combining morphology and physiology. Reinke very aptly states that if we allow morphology and development to dominate our investigations we may come to the absurd conclusion that the floral leaves are foliage-leaves and, *vice versa*, that the foliage-leaves are floral leaves. Extending the illustration we might conclude that mosses are liverworts, and that fungi are algae, etc. Reinke believes that the development of an organ should be represented as describing a curve which extends from the beginning to the point of maximum development of that organ. All intermediary stages of development are to be considered, but the special importance is to be attached to the fully developed structure. According to this view thallus, foliage-leaf, thorn, tendril, sepal, petal, stamen, pistil, should be represented as terminating at different points of the curve. With these and similar introductory considerations, the author finally enters upon the discussion of the podetia of *Cladonia*.

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* Reinke, J. Abhandlungen über Flechten. I. Das Podetium von *Caldonia*. Pringsheim's Jahrbücher, **26**: 495-523. 1894.

† Krabbe, G. Entwickelungsgeschichte und Morphologie der polymorphen Flechtengattung *Caldonia*. Ein Beitrag zur Kenntniss der Ascomyceten. Leipzig (A. Felix). 1891.

Reinke contents himself with de Bary's definition of the lichen thallus; de Bary designates it as the vegetative organ bearing the apothecia, spermagonia, and in certain instances also pycnidia. This rather negative definition is accepted by most modern lichenologists who define the vegetative organ as the structure whose prime function is to take up and assimilate food-substances. Reinke also accepts, or at least expresses his disinclination to change, de Bary's definition of the reproductive organs; that is, the reproductive organs are the apothecia and spermagonia. If the experiments and observations of Stahl* and Sturgis† prove correct it would be more correct to speak of the *carpogone* and *spermagone* as the reproductive organs; but since it is highly probable that the spermagonia are merely parasitic fungi, or since their true nature is as yet problematical, we have no scientific authority to designate them as reproductive organs. This difference of opinion does not have any important bearing upon the question under consideration. It is, however, evident that Reinke considers the spermagonia as reproductive organs.

Reinke recognizes two portions of the *Cladonia*-thallus: the horizontal portion which is also called primary thallus or protothallus, and the vertical portion, or the podetium of lichenologists. The term thallus is quite generally applied to the horizontal or primary thallus, while the term podetium is retained to designate the vertical thallus. In all instances the podetium takes its origin from the gonidial (algal) zone of the horizontal thallus. Whether the beginnings of the podetium are due to a sexual act or not, is not definitely known. Krabbe and Reinke are inclined to believe that it is nonsexual. Reinke, however, hints at a *possible* sexual act represented by a fusion of the nuclei of two neighboring hyphal cells.

The primary axis of the podetium is negatively geotropic, thus differing essentially from the transversely geotropic dorsiventral horizontal structure of the primary thallus. If the podetia branch, it is found that the negative geotropism decreases with

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* Stahl, E. Beiträge zur Entwickelungsgeschichte der Flechten, I. and II., Leipzig. 1877.

† Sturgis, W. C. On the Carpologic Structure and Development of the Collemaceae and Allied Groups. Proceedings of the American Acad. 25: 1890.

the number of branchings. In cross section the podetium is seen to have a radial structure, hollow, bearing a gonidial zone just within the outermost protective (cortical) covering. The assimilative surface of the podetium is usually much greater than that of the thallus-lobe, from which it took its origin. Both Krabbe and Schwendener * look upon the two distinctive forms of thallus as a species of alternation of generation. Wainio † believes that the apothecial stalk is converted into a vertical thallus by a form of metamorphosis. A similar view is held by Reinke; that is, the podetium was originally an apothecial stalk (perhaps comparable to that of the Caliciaceae and of *Baeomyces*) which finally became metamorphosed into a true thallus. This metamorphosis was of such a nature that the increase in size and assimilative function of the podetium corresponded to a decrease in size and function of the primary thallus.

The author enters into a more detailed discussion of the morphological characteristics of the leading types of *Cladonia* for the purpose of illustrating the structural modifications of the podetium and its relation to the primary thallus and apothecia. Life-size figures of the types accompany this discussion. Reinke quite frequently speaks of "fertile forms" when only "pycnidia" are present, which shows conclusively that he considers these structures as reproductive organs coequal in importance to the apothecia. The fact that the pycnidia (and spermagonia) may occur on either the primary thallus or the podetium, while the apothecia occur on the podetia (excepting a few *Cladonias* which are said to have no podetia or only pseudo-podetia) does not seem to raise any question in the author's mind as to the feasibility of considering the former as true sexual organs. This is only in passing, but it is well to remember that sexual organs are generally not so variable in their occurrence and position on the vegetative portion as the pycnidia and spermagonia evidently are.

Without going into further details the following summary may be given of Reinke's reasons for assuming that the podetium is a thallus rather than a reproductive organ.

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* Schwendener, S. Untersuchungen über den Flechtenthallus. Nägeli's Beiträge zur Wissenschaftlichen Botanik, 2: 169. 1860.

† Wainio, Monographia Cladoniarum Universalis. Helsingfors, 1867.

1. A gonidial layer is present whose special function is that of assimilation. This is, however, not conclusive, since all apothecia with a thalloid exciple contain gonidia (algae), and therefore aid in the process of assimilation.

2. The extreme variability in the size and form of the podetium indicates that it belongs to the vegetative portion of the plant rather than the reproductive portion. Constancy in size and form is peculiar to the organs of reproduction.

3. The association of a large primary thallus with a small podetium and, *vice versa*, a small primary thallus (or none at all) with well developed, much-branched podetia seems to indicate that the podetium is specially adapted to supplant the function of the primary thallus.

4. Cladonias with highly developed podetia (*C. furcata*, *C. rangiferina*, etc.) are quite generally sterile (devoid of apothecia) and with primary thallus rudimentary or wanting. It would be absurd to consider such plants as reproductive organs since their prime function is vegetative.

Reinke admits that the podetia are phylogenetically derived from apothecia and thus in part agrees with Krabbe. The following are the main reasons for assuming that this is the case:

1. Podetia are developed endogenously from the gonidial zone of the primary thallus, similar to the apothecia.

2. Podetia have a radial structure similar to apothecia and apothecial stalks. This is in sharp contrast to the dorsiventral structure of the primary thallus.

3. The apothecia occur upon the podetia. An apparent exception is met with in *C. miniata* in which the apothecia seem to be sessile upon the upper surface or margin of the primary thallus. In this case the podetium has become much reduced, while the primary thallus has become much enlarged.

The general conclusion at which Reinke arrives is that *the podetium is a true lichen-thallus phylogenetically derived from the apothecium.*

II.

The Systematic Position of Lichens.*

This paper is a critical review of lichenology since the time of Schwendener's epoch-making investigations.† The author credits De Bary with first having indicated the dual nature of lichens by demonstrating that species of *Nostoc* and *Chroococcus* may be converted into gelatinous lichens upon becoming penetrated with the hyphae of certain parasitic Ascomycetes. It must be remembered that as late as 1863 Schwendener still believed that the gonidia (algae) were developed upon lateral and terminal branches of the hyphae.‡ De Bary made his discovery in 1865. In 1868§ Schwendener accepted this view and added that all lichens were the result of the union of an alga with some fungus. As the result of his investigations Schwendener concludes that lichens should no longer be considered as a distinct class, but as fungi parasitic upon algae (gonidia). He states: "In development the vegetative organs and the organs of reproduction of lichens are in all respects similar to those of *Ascomycetes*." Reinke has always agreed with Schwendener in the belief that the gonidia of lichens were true algae and the hyphae true fungi. Their opinions differed, however, as to the relationship of the two organisms. Reinke was not at all willing to look upon it as a form of ordinary parasitism. During the summer of 1872, in verbal communication with Griesebach, Reinke pointed out that the relationship indicated a mutual benefit. While the alga supplied the fungus with assimilated food-substances, the latter supplied the alga with water, nitrogen, phosphorus, sulphur and mineral salts. The relation of the fungus and alga in the lichen was comparable to the relation of the root and the leaves of a tree. In order to distinguish this form of relationship (symbiosis) from parasitism (antagonistic symbiosis) it was necessary to introduce a new term. Reinke and Grisebach

* Reinke, J. Die Stellung der Flechten im Pflanzensystem. Pringsheim's Jahrbücher, **26**: 524–542. 1894.

† Schwendener, S. Die Algentypen der Flechten-gonidien. Basel, 1869.

‡ Schwendener, S. Nägeli's Beiträge zur Wissenschaftlichen Botanik, **3**: 133–136. 1863.

§ Schwendener, S. Nägeli's Beiträge zur Wissenschaftlichen Botanik, **4**: 195–202. 1868.

finally hit upon the word "consortism" as being especially appropriate. Reinke gives conclusive evidence that he has not been duly credited with first having pointed out the true conditions met with in the lichen thallus. This credit is given to de Bary, who is generally supposed to have been the first to point out and explain the phenomenon of "symbiosis" * as it occurs in lichens. The author had, however, previously explained this condition in three different publications.† From these it is evident that De Bary was not the discoverer of the phenomenon now known as mutualistic symbiosis, and that the term consortism antedates that of symbiosis. Reinke explains his views with regard to the lichen-thallus more fully as follows: "We have, therefore, in the thallus of lichens, a consortism, the components of which form a unit, a morphological individual, somewhat as the different tissues in a higher plant unite to form the individual. The fact that the alga can exist independently is dependent upon its ability to assimulate carbon. In the state of consortism, at least in the heteromerous thallus, the alga is nourished by the enclosing fungus ; that is it receives from the hyphae the necessary minerals, nitrogen, oxygen, hydrogen and water. The alga in return supplies the fungus with the essential carbon compounds. From this it is evident that the components (alga and fungus) are biologically associated, mutually dependent upon each other, for the formation of the organic substances required for the upbuilding of the common body." The above is certainly conclusive evidence that Reinke had a correct view of the mutualistic relationship of alga and fungus in the lichen-thallus and furthermore that he was convinced that the lichen formed an autonomous structure.

The author expresses it as his opinion that the fungi of the higher Ascolichenes no longer exist independently, perhaps never so existed. The alga is, however, still able to lead an independent existence. It is also evident that there are free algae closely related, if not identical with the gonidia of lichens. This fact is of great importance in the consideration of the phylogenetic devel-

* De Bary, Die Erscheinung der Symbiose. Strassburg, 1879.

† Reinke, J. Göttinger Nachrichten. p. 100. 1872.

Reinke, J. Morphologische Abhandlungen. Leipzig, 1873.

Reinke and Grisebach, A. S. Oersted's System der Pilze, Lichenen und Algen. 1873.

opment of lichens. It is practically impossible to determine what free fungi are identical with the fungi of lichens. All investigators in this line have met with very unsatisfactory results, a thing naturally to be expected. According to Tavel* the fungi of the Collemaceae, Arthoniae and Lecideaceae are more or less closely related to the Patellariaceae. The relationship of the fungi of the Pertusariae, Lecanareae, Pannarieae, Umbilicarieae, Peltidiaceae, Parmeliaceae, Usneaceae, Cladoniaceae, Sphaerophoreae, Ephebeae and Lichineae is practically unknown. The Verrucarieae, Decampieae and Endocarpieae are related to the Amphisphaeriae, Sphaerelloideae. Such uncertainty is certainly very unsatisfactory

Although there may be algae, such as *Cystococcus humicola*, *Pleurococcus vulgaris*, *Nostoc lichenoides*, etc., which only await the opportunity to unite with some fungus to form a lichen, yet it is evident that no true Ascomycete has the power to enter into such a union. There is great uncertainty as to the exact method by which the first lichen or lichens were formed. The author makes the following hypothetical assumption : " In the beginning several lichens were formed by the union of true fungi with algae. According to Möller† such a process is now going on in the case of *Cora pavonia* and the related forms of *Dictyonema* and *Laudatea* The gelatinous lichens are very likely the oldest forms of the Ascolichenes. Such a gelatinous lichen took its origin as the result of the parasitic union of a fungus and a spherical colony of *Nostoc lichenoides*.' The question of the origin of the fungus coincides with the question of the phylogenetic origin of parasitic fungi in general and need not be further discussed. The fungus which at first behaved like a true parasite (antagonistic symbiosis) took its entire food-supply from the nostoc. The condition of mutualism (consartism) was a phylogenetic product ; perhaps due to natural selection or other formative causes resulting from the union of alga and fungus. From this proto-*Collema* other gelatinous lichens were evolved ; finally also such with heteromerous thallus. It is probable that in the course of phylogenetic

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* Tavel, F. Vergleichende Morphologie der Pilze, pp. 94 and 108. Jena, 1892.

† Möller, A. Ueber die eine Thelephoree, welche die Hymenolichenen : *Cora Dictyonema* und *Laudatea* bildet. Flora 77 : 254–278. 1893.

processes the developing spores of gelatinous lichens acquired the ability to enter into a mutually symbiotic union with other algae. A series phylogenetically derived from *Collema* may have taken an upward course, that is, proceeded from the lower to the higher, from the simpler to the more complex. As an example we may cite the natural series *Collema*, *Leptogium*, *Hydrothyria*, *Peltigera*. If *Stictina* is derived from *Peltigera*, *Sticta*, which is evidently *Stictina* with bright green algae, would also be included in the series. Every phylogenetically derived lichen-type constituted the beginning of a new series which may have proceeded upward or downward; that is in the direction of either higher or lower forms. In certain cases it is difficult to decide whether given lichens form the beginnings of a series or whether they are degenerate forms. Among such doubtful forms are included *Biatora uliginosa*, *Thelidium minutulum*, and species of *Buellia* and *Arthonia*. Many of these plants live parasitically upon other lichens, and no doubt bear a relation to these similar to the relation of *Cuscuta* and *Monotropa* to the chlorophyll-bearing genera of the same family. The above summary leads to the conclusion that there is a natural system of lichens distinct from that of fungi.

The author deplores the pernicious effect of Schwendener's plan of the arrangement of lichens. As a result lichens received only casual mention in an appendix to the different groups of lichens. Lichenologists (systematic) in general have strongly opposed Schwendener's plan of classification. Although Reinke has always sympathized with these lichenologists, yet he regrets very much that they should have made their special attack upon Schwendener's theory of the dual nature of lichens.

The following is a brief summary of the leading items discussed in this paper:

1. The true relation of fungus and alga in the lichen-thallus was first pointed out by Reinke.

2. The term *Consortism* antedates the term *Symbiosis*.

3. Schwendener's (De Bary's) theory of the dual nature of lichens is fully accepted.

4. Most of the algal types occurring in lichens have been specifically determined. The fungal types no longer exist (at least in most cases) and can therefore not be determined.

5. A lichen is a phylogenetically derived morphological unit.

6. Lichens form groups of natural series phylogenetically derived from distinct prototypes. Lichens have, therefore a polyphyletic origin.

7. Lichens differ from the fungi morphologically as well as physiologically.

The following are the general conclusions at which Reinke arrives:

1. Although fully accepting Schwendener's theory, lichens are phylogenetically, morphologically and physiologically wholly distinct from fungi, and it is therefore inconsistent to arrange them under fungi.

2. Lichens form a natural group coequal in systematic importance with fungi and algae.

Since Reinke has written this paper Schwendener in a personal interview with E. L. Gregory * stated that he had no objection to the proposed plan of classification. Tubeuf, † as well as other recent authors, expresses the opinion that the lichen is an autonomous structure, a morphological unit. There are also strong objections, such as those cited by Lindau. ‡

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 107.

Two Nuttallian Species of Oxalis.

BY JOHN K. SMALL.

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Two Nuttallian Species of Oxalis.

By John K. Small.

In the earlier part of this century Mr. Nuttall collected two species of *Oxalis* on the Pacific slope; the one he secured in Oregon, the other in California. The collector sent descriptions of his two new species to Torrey and Gray while they were publishing their Flora of North America. The descriptions were accompanied by specimens which are now preserved in the Herbarium of Columbia University.

Torrey and Gray reduced both the species to *Oxalis corniculata** and printed Mr. Nuttall's descriptions in a foot-note and thus the two plants for many years, and one to the present time, remained without further recognition.

The first of the two species described was *Oxalis pumila*.† It was said to occur in "Forests of the Rocky Mountains and Oregon." The original specimen I have to refer to is from Oregon, and consists of two plants, the one in flower the other in fruit. This form was later described by Professor Trelease as *Oxalis Suksdorfii*,‡ which name may stand on account of the earlier described *Oxalis pumila*,§ of D'Urville. The ample supply of *Oxalis Suksdorfii* which we now have from Oregon, agrees in all details with Mr. Nuttall's original specimens of *Oxalis pumila*. In addition to our material from Oregon, I find two specimens from California; they were collected many years ago and sent to Dr. Torrey. The

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* Fl. N. A. 1 : 212.

† T. and G. Fl. N. A. 1 : 212.

‡ Mem. Bost. Soc. Nat. Hist. 4 : 89.

§ Mem. Soc. Linn. Par. 4 : 616. 1826.

record accompanying one is simply "California, Rev. A. Fitch," while the other was collected by Dr. Parry when on the Mexican Boundary Survey, "between 32° and 36° N. Lat., and 114°–121° W. Long."

Professor Trelease referred with some doubt, both the original specimens of Mr. Nuttall and the later ones from California to his *Oxalis corniculata* var. (?) *macrantha*,* which position, in the light of recent material and our present knowledge of geographic distribution, cannot be maintained. The species is beautifully distinct, and in addition to other characters, the pod is diagnostic, as Mr. Nuttall intimates,† differing from that of all other relatives in its short conic form. As descriptions of the plant are not easy of access I append the following:

OXALIS SUKSDORFII Trelease, Mem. Bost. Soc. Nat. Hist. 4: 89. 1888.

Oxalis pumila Nutt.; T. & G. Fl. N. A. 1: 212, 183. Not D'Urv. 1826.

Perennial by a slender horizontal or creeping woody rootstock, caulescent, low and bushy or much elongated, somewhat pilose or sparingly villous. Stems ascending or decumbent, .5–4 dm. long, simple or nearly so; leaves palmately 3-foliolate, 2–3 cm. broad, usually glabrate except the ciliate edge; petioles slender, 3–8 cm. long; stipules obsolete, or a narrow dilation; leaflets broader than long, sharply notched, the lobes usually unequal, ciliate; peduncles usually surpassing the leaves; pedicels forming umbellate cymes, commonly 2, subtended by linear-subulate bracts; flowers usually bright yellow, about 2 cm. broad; sepals oblong or oblong-lanceolate, 4–5 mm. long, obtuse, villous, erect or ascending; petals obovate, 12–15 mm. long, undulate; filaments pilose; capsule conic, 8–11 mm. long, about twice as long as the sepals, usually pubescent; seed oval in outline, nearly 2.5 mm. long, its tubercles almost united into continuous transverse ridges.

Oregon and California.

The second species described by Mr. Nuttall in this connection, under the name *Oxalis pilosa* is just as worthy of specific rank as *Oxalis Suksdorfii.* It is apparently rarer; however the scarcity of it in our herbaria may be due to the fact that some collectors are inclined to pass by apparently well-known species in the field. The history of this species is shorter than that of *Oxalis*

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* Mem. Bost. Soc. Nat. Hist. 4: 88.

†T. & G. Fl. N. A. 1: 212.

Suksdorfii; it begins with the original description* and ends with its union to *Oxalis corniculata* var. (?) *macrantha*,† as in the case of its sister species.

Mr. Nuttall collected his type in "Woods around St. Barbara, California," as is shown by his description and the label accompanying the type. The original specimen is sufficient to mark it as a very distinct species, and to support this I found an ample specimen preserved in the Torrey herbarium, which agrees with Nuttall's type in every particular. This second specimen consists of two plants which were collected in the "Valley of the Sacramento, California," by Dr. Stillman.

The gross characters which separate *Oxalis pilosa* from *Oxalis Suksdorfii* are habit, the densely pale pilose pubescence found on the stems, petioles, peduncles and pedicels, and the longer columnar pods. The species doubtlesss occurs in many herbaria. I give the following description:

OXALIS PILOSA Nutt.; T. & G. Fl. N. A. 1: 212. 1838.

Perennial by a woody base, caulescent, stoutish, densely pilose throughout, pale green. Stem erect, ascending, or decumbent, 1–3 dm. long, usually simple, woody below; leaves peltately 3-foliolate, 1–2 cm. broad, pilose on both sides; petioles slender, 2–6 cm. long, with narrow dilated stipules; leaflets mostly broader than long, sharply notched at the apex, ciliate, the lobes equal or nearly so; peduncles stoutish, surpassing the subtending leaves, topped by 1–3 umbellate-cymose pedicels which are subtended by linear-subulate bracts; flowers yellow, nearly 2 cm. broad, rarely solitary; sepals ovate-lanceolate or oblong-lanceolate, 4–5 mm. long, obtuse, pilose; petals obovate, notched, 12–15 mm. long; filaments pilose; capsule columnar, 1.4–1.7 cm. long, abruptly pointed, tipped by the spreading style-tips, clothed by a minute gray pubescence, commonly longer than the reflexed pedicels; seed obovoid, 1.5 mm. long, marked with slightly interrupted transverse ridges.

California, from the Valley of the Sacramento to Santa Barbara.

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* T. & G. Fl. N. A. 1: 212.

† Mem. Bot. Soc. Nat. Hist. 4: 88.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 108.

The North American Species of Agrimonia.

(PLATES 282–283.)

Geum Canadense flavum (Porter) Britton, a valid species.

BY EUGENE P. BICKNELL.

[Reprinted from THE BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 23, No. 12, Dec. 1896.]

The North American Species of Agrimonia.

By Eugene P. Bicknell.

(Plates 282, 283.)

Perhaps no one of our long-known plants has more effectually escaped a right understanding by botanists than the familiar Agrimony of the Eastern States, long current in local floras and text-books as *Agrimonia Eupatoria* L. This name, it seems, has been doing duty since the beginning of American botany for a considerable *group* of related species, of which at least five may now be clearly recognized. Nor is this all; for, as first shown by Dr. Britton (Bull. Torr. Club, **18**: 366, 1891), the true *Agrimonia Eupatoria* is not known at all as an American plant and is very distinct from that particular one of our native species which has been more especially referred to it.

For the initial fault in this misunderstanding we must go back to "Species Plantarum," wherein, under *A. Eupatoria*, we find the citation "Gron. Virg.," although the inconsistency follows that the species is attributed to Europe only. Walter seems to have been the first of our writers to adopt the name definitively into the American flora (Fl. Car. 1788), though it is not now possible to determine the exact sense in which he used it. And so with most subsequent authors the name as used has doubtless a composite significance, though mainly intended to designate our most common and generally distributed species.

Muhlenberg appears to have been the first to perceive that this plant was not identical with the European and he gave it its first distinctive appellation—*hirsuta* (Cat. 47, 1813). Muhlenberg, indeed, seems to have better understood our group of species than any subsequent writer except Wallroth, although he has been quite overlooked, and his name *hirsuta*, for our representative species, which it now becomes necessary to adopt, was afterwards independently used by Torrey for a more hairy form of the same plant.

The genus *Agrimonia*, with especial reference to the North American species, may be characterized as follows:

AGRIMONIA L. Sp. Pl. 448. 1753.

Perennial, erect or assurgent, mostly glandulose herbs, simple or branched above, with alternate, conspicuously stipulate, odd-pinnate leaves bearing interposed subleaflets, and small regular perfect yellow flowers in spicate racemes. Flowers short-pedicelled or subsessile, axillary from small 3-cleft bracts and with a pair of trifid or entire bracteoles at the base of the calyx. Calyx-tube in fruit obconic, turbinate or hemispheric, short-stipitate, sulcate, uncinate-spinose or bristly above, contracted at the throat to form a flattened or convex disk which supports a central process formed by the five connivent calyx-lobes. Petals 5, inserted with the 3–15 stamens in the margin of a waxy disk which surrounds the terminal styles in the throat of the calyx; anther-cells mostly separated by a broad connective. Carpels 2, included, developing into one or sometimes two one-seeded achenes with membranous testae contained in the indurated calyx tube, seeds suspended.

Leaflets crenate, dentate, serrate or incised, the teeth mucronulete or having a minute callosity in the tip. Lower stipules smaller and simpler than those above. Stamens variable in number in the some species, often fewer than normally in the terminal or later flowers. Roots either fibrous or tuberous-thickened.

The North American species, as far as known, are as follows. The ranges given are based alone on specimens actually examined, and are doubtless subject to considerable extension in some cases.

1. AGRIMONIA HIRSUTA (Muhl.).

A. Eupatoria of most American authors, not L.

A. eupatoria hirsuta Muhl. Cat. ed 1, 47. 1813.

A. Eupatoria β *hirsuta* Torr. Fl. 473. 1824.

A. gryposepala Wallr. Beitr. 1: 49. 1842.

New Brunswick to Minnesota and Nebraska, south to North Carolina; California.

2. AGRIMONIA STRIATA Michx.

A. striata Michx. Fl. Bor. Am. 1: 287. 1803 (*fide* T. & G.).

A. eupatoria β *glabra* Muhl. Cat. ed. 1, 47. 1813.

A. parviflora DC. Prodr. 2: 587, excl. Aiton. Not Soland. 1821.

A. Eupatoria δ *parviflora* Hook. Fl. Bor. Am. 197. 1830.

A. microcarpa Wallr. Beitr. 1: 39. 1842.

A. rostellata Wallr. Beitr. 1: 42. 1842. ="*A. americana* Luca in herb." Wallr. loc. cit. as syn.

Southeastern New York, and doubtless Connecticut, to Virginia, west to Missouri.

3. Agrimonia pumila Muhl.

A. pumila Muhl. Cat. ed. 1, 47. 1813.

Pennsylvania and Maryland to Florida, west to Kentucky and Louisiana.

4. Agrimonia mollis (T. & G.) Britton.

A. Eupatoria γ mollis T. & G. Fl. 1: 431. 1840.

A. platycarpa Wallr. Beitr. 1: 38. 1842. =" *A. Eupatoria americana* Beyrich in Herb." *fide* Wallr. loc. cit.

A. pubescens Wallr. Beitr. 1: 45. 1842. =" *A. parviflora* Kinn in Herb." *fide* Wallr. loc. cit.

A. mollis Britton, Bull. Torr. Club, 19: 221. 1892.

Southeastern New York, and doubtless Connecticut, to Michigan, south to Georgia, Tennessee and Kansas.

5. Agrimonia Brittoniana n. sp.

New Brunswick and Quebec to western New York and doubtless further north and west, south to Ulster and Westchester counties, N. Y., and along the Alleghenies to West Virginia; Montana; Laramie Peak, Wyoming and, either this or an allied form, in Arizona and New Mexico.

6. Agrimonia parviflora Soland.

A. parviflora Soland. in Ait. Hort. Kew. 2: 130. 1789.

A. Eupatoria Michx. Fl. Bor. Am. 1: 287. 1803, chiefly, *fide* T. & G. Not L.

A. suaveolens Pursh, Fl. 1: 335. 1814.

A. serrifolia Wallr. Beitr. 1: 40. 1842. = " *A. Eupatoria americana* Kinn in herb." *fide* Wallr. loc. cit.

Southeastern New York, and doubtless Connecticut, to Illinois and Missouri, south to Georgia and Mississippi.

7. Agrimonia incisa T. & G.

A. incisa T. & G., Fl. 1: 431. 1840.

Florida, Alabama, Georgia, South and North Carolina.

Key to the North American Species of Agrimonia.

Leaflets serrate, dentate or crenate with numerous teeth.

Racemes and leaves beneath glabrous or with loose spreading hairs.

Roots not tuberous; fruit large, turbinate, with numerous radiating bristles. 1. *A. hirsuta*.

Roots tuberous-thickened; fruit very small, hemispheric, with few ascending or erect bristles. 2. *A. striata*.

Racemes and lower surface of the leaves closely or softly pubescent.

Roots tuberous; stems pubescent; leaflets not glandular-dotted beneath.

Small or simple, with elongated terminal raceme, leaflets 3–5. 3. *A. pumila.*

Larger, branched, leaflets 5–11. 4. *A. mollis.*

Roots not tuberous; stems hirsute; leaflets glandular-dotted beneath.

Leaflets 5–9, oblong or rhomboid; fruit large, the bristles connivent. 5. *A. Brittoniana.*

Leaflets 9–23, lanceolate; fruit small, the bristles radiate. 6. *A. parviflora.*

Leaflets incised with few salient teeth. 7. *A. incisa.*

1. Agrimonia hirsuta (Muhl.).

Commonly 3°–4° tall (2°–6°), simple, to loosely wide branched above, minutely glandulose and somewhat viscid on the branches, aromatic. Stem usually zig-zag from leaf to leaf, villous-hirsute with slender spreading hairs. Leaves bright green, large, 4′–12′ long, 3′–8′ wide, the villous leaf-stalks usually with short petiolar portion. Leaflets large, rather thin, commonly three pairs (2–4 pairs), elliptic, broadly oblong or obovate-oblong, acute, sessile or subsessile, often with rounded or subcordate base, the odd leaflet short-stalked or subsessile with narrowed base, coarsely serrate with acute or somewhat rounded mucronulate teeth, the margins ciliate-fringed, upper surface glabrous or with short, scattered, appressed hairs, lower surface minutely, often sparsely, pulverulent-glandulose and with scattered hairs on the larger nerves, rarely subpubescent. A frequent size of the leaflets is abo ut 2½′ × 1¼′, an extremesize 5′ × 3′. Interposed leaflets normally three pairs in the distal interspace, fewer or smaller in the lower interspaces, the middle pair much the largest, ovate or obovate from a broad base, acutely lobed, often subopposite, in weak plants sometimes much reduced, rarely to a small entire pair. Stipules normally very large, sometimes over an inch broad, the pairs cordate-amplexicaule, often overlapping around the stem, openly cut-serrate or dentate-lobed in the rounded outer margin which is abruptly contracted into the ovate-acuminate incurved terminal lobe. In reduced plants the stipules are smaller and narrower, the lowermost sometimes entire. Branches openly compound, widely spreading or loosely ascending, bearing spreading racemes. Racemes commonly under a foot in length (4′–16′), often inclined in fruit, minutely pulverulent-glandular and thinly spreading-villose, somewhat closely many-flowered or the lower flowers distant on slender ascending pedicels 2″–5″ long, the uppermost sometimes subverticillate clustered. Bracts relatively large, the narrow lobes ciliate-fringed, often exceeding the flowers at anthesis; bracteoles lanceolate-attenuate, narrowly 3-cleft or entire. Flowers 4″–6″ broad, bright yellow; anther-cells separated by a distinct connective; flower buds ovoid, narrowed to a prominent point, minutely glandulose. Mature fruit reflexed, large, 3″–6″ long over all and as wide across the bristles, short-turbinate, mostly contracted abruptly to the stipitate base, strongly fluted, pulverulent-glandulose, often slightly strigose at the extreme base; bristles numerous, spinose, loosely covering the convex disk, the lowermost reflexed from the prominently expanded margin of the disk, those above spreading and erect, the innermost slightly exceeding the acute beak-like calycular process and at least half the length of the fruit. The mature calyx-lobes taper into rigid, minutely hooked points which are finally incurved together, a feature which Walroth recognized by his name *gryposepala*. The roots are fibrous, often slightly thickened throughout their length, but never tuberous. They are not fragrant as those of the European *A. Eupatoria* are said to be. (Plate 282, fig. 1.)

Borders of woods and thickets in sun or half shade, growing in vigorous groups or sometimes scattered.

Begins to flower at New York in the first week of July, two or three weeks in advance of any other species, and ceases to flower in August, also earlier than any of its congeners. The date of first flowering has ranged in nine years from June 29 to July 10.

The young herbage, when crushed, exhales an agreeable fragrance which somtimes even suggests that of the Japanese Honeysuckle.

It may be noted that the name *hirsuta* of Muhlenberg now adopted for this plant displaces *hirsuta* of Bongard for a Brazilian species.

2. Agrimonia striata Michx.

Slender, commonly 1½°–2½° high (8′–5°, simple to delicately paniculate-branched, minutely glandulose nearly throughout, viscid above and in the racemes, agreeably aromatic. Stem glabrous or with scattered spreading hairs (sometimes thinly hirsute at the base, and rarely finely subpubescent above), the slender leafstalks thinly hairy-pubescent to glabrate, scabrous on the lower side. Leaves rarely reaching nearly the extreme size of those of *A. hirsuta*, but usually much smaller. Leaflets sessile or subpetiolulate or the odd leaflet on a slender, sometimes foliolate stalk, commonly two pairs (1–4 pairs, the larger number occurring only rarely and on the lowest leaves), thin, glabrous or nearly so above, below sprinkled with pellucid glandules and sparingly hispidulous on the larger nerves, the margins subciliate. The leaflets are somewhat variable in form, but are commonly blunter and more obovate-cuneate than those of *hirsuta*, with broader, less acute teeth, the marginal pattern mostly coarsely crenate-dentate to boldly crenate; sometimes they are throughout narrowly obovate-oblong with broad, shallow, semicrenate teeth; on the reduced often trifoliate upper leaves they may be very narrow and sharply dentate-serrate. Interposed leafiets elliptic to obovate, acute, often confined to the distal interspace, usually a small or minute entire pair, occasionally larger and dentate-lobed, rarely with a minute pair on either side. Stipules smaller and narrower than in *hirsuta*, rarely becoming ½′ wide, often very small, lanceolate to semi-cordate, cut-serrate to deeply incised, the lowest often entire. Inflorescence varying from a short terminal raceme to a delicately branched nearly naked loose panicle, the glandulose racemes only 3′–6′ long and rather loosely flowered. Flowers very small, 2″–3″ wide, pale yellow, on slightly spreading pedicels 1″ or less long; anther-cells contiguous. Bracts minute, ciliolate; bracteoles ovate, 3-lobed or entire. Flower-buds subglobose, almost truncate, the sepals ovate-oblong, obtuse, downy-canescent within the apical margins. Mature fruit subspreading or nodding, very small, 1″–1½″ wide, the body subhemispheric, 1″ long below the marginless rim, pellucid-glandulose, bristles few and weak, short, erect and slightly spreading, equalled or exceeded by the truncate calycular process which caps the very tumid disk; sulcae rather broad and shallow, converging into the narrow and curved stipe-like base. Roots developing tuberous thickenings which reach a size of 3′ × 2″; elongated roots sometimes show two or three successive swellings. (Plate 283, fig. 6.)

Hilly woodland, mostly in light rich soil; of scattered growth, or forming loose colonies, but never massed in close groups.

Begins to flower at New York from about the middle to the end of July and continues to bloom into early September.

This species need be compared only with *A. hirsuta* which, in its stouter forms, it sometimes closely resembles. It differs most obviously in its tuberous roots, lesser size and more slender habit, nearly glabrous stem and branches, delicate short racemes, smaller flowers with obtuse sepals, much smaller hemispheric fruit with unmargined disk and few mostly erect bristles, smaller narrower stipules and more crenate leaves. The leaves, generally fewer than in *A. hirsuta*, are more obovate in general outline, the more slender leafstalk rougher below and more narrowly and deeply grooved along the upper side, the leaflets mostly more obversely broadened and rounded at the apex, the pairs separated by wider intervals, the lowest pair relatively much smaller, the interposed leaflets much less developed, the petiolar portion of the leafstalk longer. In its earlier stages the inflorescence is strikingly different from that of *hirsuta*. In the latter the longer and stouter villous racemes are closely flowered and conspicuously bracteose; in *striata* the delicately slender rearly glabrous racemes are more viscid-glandular and much less closely flowered, with minute inconspicuous bracts and rounded-truncate instead of pointed flower buds.

In adopting the name *striata* for this species I have simply followed Dr. Gray who, having seen Michaux's material, cites the name as a synonym, not of *A. Eupatoria*, but of *A. Eupatoria* var. *parviflora* of Hooker, the plant here taken up, giving to the reference his mark of authentication. (T. & G. Fl. loc. cit.).

3. Agrimonia pumila Muhl.

The smallest of our species, 1°–2° high, erect or more slender and assurgent, simple or with a few ascending branches from the lower part of the elongated terminal raceme. Stem clothed with loose often coarse pubescence and hirsute with spreading hairs which become subappressed above and obsolete in the pubescent racemes. Leaves often crowded low on the stem, often trifoliate, small, 1½′–3½′ long, 1½′–2½′ wide, the upper ones much reduced. Leaflets firm, 1–2 pairs, the lower pair always small, oval to obovate or the odd leaflet cuneate, sessile or subpetiolulate, obtuse or rounded at the apex or sometimes acute, crenate or dentate or sometimes boldly crenate-dentate, commonly 1′–1½′ long, dark-green above and loosely appressed-hairy to nearly smooth, the margins loosely appressed-ciliate, paler and softly pubescent below, pilose-pubescent or hairy along the veins, obscurely, if at all glandulose; leafstalk villous; subleaflets wanting or a minute pair, entire or few-dentate. Stipules small, the main pairs rounded and cordate-clasping, acutely dentate-lobed or incised, sometimes dentate on the inner margin. Racemes loosely-flowered, often remotely-flowered below. Flowers small, the buds subglobose. Fruit small, 2″ long, 1″–1½″ wide, turbinate or subhemispheric, minutely glandulose, often canescent in the sinuses when young, the disk mostly obscurely margined and rising to the short and broad calycular process, the bristles loosely ascending and erect. Roots developing short tuberous thickenings. (Plate 283, fig. 5.)

This species is nearly related to *A. mollis* and occasional depauperate plants of the latter are with difficulty distinguishable from it. I think there can be no doubt, however, that the two species are distinct and that a comparative study of growing plants would disclose more pronounced differences than dried specimens have revealed. The uniformly small size and simple or nearly simple habit of *pumila* and its slender and elongated loosely-flowered raceme are usually sufficient to distinguish it. The pubescence seems to be generally coarser and more hirsute than in *mollis*, and the much smaller, mostly trifoliate leaves more crowded on the lower part of the stem and apparently of thicker texture. I have not seen satisfactory material in mature fruit. The range of the plant is clearly more restricted northward than that of *mollis*, and more extended southward as far as at present known.

I adopt Muhlenberg's name *pumila* for this species with some hesitation and only to avoid the alternative of conferring a new name. Muhlenberg characterized his plant by the one word "little" and gave its habitat as Mississippi. Applying the rule of exclusion it would appear that only this species could have been intended. If it should be found that *A. mollis* extends into Mississippi the name would have only a dubious claim to availability.

4. Agrimonia mollis (T. & G.) Britton.

Not aromatic and obscurely if at all glandulose, mostly slender and 2°–3° high (1° to over 6°), the branches ascending or sometimes spreading, either few and simple or forming a loose panicle which exceptionally attains a spread of as much as 2°–3°. Stem below loosely tomentose-pubescent and weakly villose with spreading or subspreading hairs, becoming finely hoary-tomentose or subappressed pubescent above and in the racemes. Leaves rather dark green, 3′–12′ long, 2′–7′ wide, a common size being 5′ or 6′ by 3′ or 4′. Leaflets commonly 2 or 3 loosely separated pairs (1–4 pairs), mostly obovate-oblong, varying from obovate to elliptic, subsessile, rounded or somewhat acute at apex, dentate-serrate to crenate, the odd leaflet mostly obovate, often on a foliolate stalk, reaching an extreme size of 4½′ × 2′, the largest lateral leaflets becoming 3′ × 1½′; upper surface sparsely hirtellous-pubescent and roughish to glabrate, the margins finely subappressed-ciliate, lower surface paler and minutely downy to velvety-pubescent; leafstalk finely pubescent and somewhat tomentose-villose. Stipules varying from small, lanceolate and entire on the lower leaves and in dwarf plants to cordate-clasping with cut-serrate or incised outer margin, on stout plants sometimes 2′ long by 1′ wide. Interposed leaflets often only a small entire pair in the distal interspace, sometimes larger, obovate-oblong and dentate above with a single minute one or a pair on either side. Racemes slender, mostly 5′–10′ long, rarely 16′, rather loosely flowered. Flower-buds rounded, scarcely or not at all glandulose. Flowers 3″–5″ broad, rather deep yellow; anthers with broad connective. Bracts and bracteoles pilose-ciliate, very small, at least the bracts narrowly 3-cleft. Fruit before maturity oblong and ascending, later reflexed or subspreading on short appressed pedicels, minutely subglandulose and slightly strigose, small, 2″–2½″ long, 1½″–2″ wide, narrowly turbinate to subhemispheric, often with a somewhat narrowed nonsulcate basal portion, or the lowest fruit of the racemes sometimes depressed-turbinate, marginless or obscurely margined, the disk flat or slightly convex with obtuse sepaline process, bristles loosely ascending or clôser and nearly erect, equalling the body of the fruit or only half its length. Roots tuberous-thickened as in *A. striata*, but the swellings often thicker and less tapering at either end, often club-shaped. (Plate 282, fig. 3.)

Dry open woods and copses and weedy banks and hillsides. Of scattered or solitary habit of growth.

Begins to flower at New York from the middle to the end of July and blooms later than any other species; belated flowers are sometimes to be found at the middle of October.

Reduced plants are sometimes trifoliate nearly throughout and simulate *A. pumila*. It will be usually evident to the collector of such forms, however, that they represent a state of imperfect development under unfavorable conditions of growth.

This is the most variable of our species and runs into several unstable forms. It should not be overlooked, however, that it shows a well-defined tendency to separate into two particular forms or varieties. Extreme examples of both are common and exhibit so considerable a degree of divergence that the eye always gives them instant recognition. Although both varieties are to be found holding their characters perfectly under identical conditions of soil and situation, intermediate forms, or what appear so to be, are of such frequent occurrence that I have not been able to satisfy myself of the expediency of giving a distinctive varietal name. For the sake of definiteness, however, the foregoing description of *A. mollis* has been made to cover only the form represented by the type, a specimen of which is preserved in the Herbarium of

Columbia University (" Red River, Dr. Pitcher"), excluding its variety, which may be separately characterized as follows:

Pubescence throughout denser and more pilose than in the type, the smaller and narrower leaves dull grayish green, the leaflets much narrower and dentate rather than crenate, the pairs closer and often more numerous. The hairs of the stem are longer and weaker than in the type and often loosely appressed, the pubescence above tending to become dense and pilose-canescent. The leaflets are mostly 4 pairs, though often 5–6 pairs on the narrowed lower leaves, narrowly-oblong (linear- or lanceolate-oblong) to elliptic, often inequilateral and backwardly subfalcate, blunt or subacute, abruptly narrowed or rounded at the sessile base, mostly dentate or dentate-serrate, often with broad, shallow, uneven teeth, the odd one mostly sessile, or when petiolulate frequently cleft basally into a pair of narrow decurrent lobes, above finely pubescent to softly appressed pilose, whitened below and softly appressed pubescent, the veins pilose, subleaflets narrower than in the type, often borne well forward in the interspace. Stipules irregularly cut-serrate or dentate-lobed, usually less incised than in the type with shorter termination, the upper ones often dentate-serrate on the inner margin and more spreading. Fruit often with more convex disk and longer more spreading bristles, usually also with a perceptible rim. Apparently the tuberous thickenings of the roots tend to become stouter than in type and to develop on shorter roots; the largest found were 3½′ long by 3½″ thick. (Plate 282, fig. 4.)

The specimens that have come under my observation would appear to indicate that this form was of more coastwise range than the type extending from southern New York to Virginia Beach and to middle North Carolina and East Tennessee.

5. Agrimonia Brittoniana n. sp.

Becoming stout and tall and strongly virgate-branched, 2°–7° high (6° 9′ at York Harbor, Maine), the stems sometimes 4″–5″ thick at the base, erect, but often leaning under the weight of the heavy fruiting racemes, somewhat aromatic. Stem roughened with glandular papillae and hirsute with short spreading brownish hair which passes into a downy or pilose-hairy pubescence in the racemes. Leaves numerous, often ascending or subappressed, 4′–8′ long, 2′–4′ wide, the villous pubescent leafstalks downy-tomentose on the upper side. Leaflets 3–4 pairs or 5–6 pairs on the narrower and longer-petioled lower leaves, often directed sharply forward, strongly veined, becoming thickish and rugose, dark green above and more or less hispidulous or scabrous, at least near the edges, the margins finely ciliolate, below paler and pubescent (soft-pubescent to nearly glabrous) with longer usually subappressed brownish hairs on the nerves and freely sprinkled with minute glistening glandules, in shape lanceolate to elliptic or ovate-elliptic, tapering from near the middle to either end, often decidedly tetragonal or rhomboid, acuminate or very acute, sharply serrate with mucronulate often deeply cut teeth (rarely with broader even subcrenate teeth), the narrowed base and acuminate apex often entire, usually petiolulate or the distal pair sessile and decurrent, the odd leaflet sessile or on a foliolate stalk and frequently pinnatifid at the base, the lateral leaflets more rarely basally pinnatifid, but never on the lower side in the distal pair. A common size of the leaflets is $2' \times \frac{3}{4}'$, and extreme size $3\frac{1}{2}' \times 1\frac{1}{2}'$ (on the lower leaves the leaflets are often shorter and less pointed with more deeply cut narrower teeth). Interposed leaflets 2–7 pairs, frequently subopposite, narrow, often linear-oblong, the main pair dentate-serrate above the middle, the others much smaller or minute, entire; not seldom a minute pair subtends a pair of leaflets like a set of stipels. Stipules lanceolate to half ovate, laciniate or cut-lobed, the terminal lobe broader and acuminate sometimes with one or two teeth on the inner margin. Main racemes 12′–18′ long, obscurely pulverulent beneath the pubescence, densely flowered except near the base, some of the flowers often subverticillate-clustered, rarely loosely flowered, erect or ascending, at maturity often declined from the weight of the abundant fruit. Flower-buds mammillate; flowers 3″–5″ wide, shorter-pedicelled than in *hirsuta*, the petals more rounded, mostly thicker and deeper yellow; anthers smaller with narrower connective; bracts smaller and less ciliate; bracteoles ovate, short-acuminate, entire or slightly lobed. Mature fruit closely reflexed against the pedicel and stem, large, 2″–3″ broad, 3″–4″ long, rather long-turbinate, the walls thickened and much indurated, strongly fluted between the deep furrows, minutely puberulent-granular and with traces of appressed hairs, the furrows strigose-canescent; disk becoming flat or concave, marginless; bristles numerous, short, one-quarter to one-third the length of the fruit, at first ascending and erect, finally connivent in a conical mass over the concealed calycular process. Sepals less acuminate than in *hirsuta* and more canescent within the tip, the apex at maturity scarcely hooked. The tips of the bracts, sepals and bristles with the callosities tipping the teeth of the leaves early become tinged with reddish-purple. Rootstock much as in *hirsuta*, but even stouter, the long roots as in that species slightly thickened throughout and not tubiferous. (Plate 282, fig. 2.)

Roadsides and borders of woods, flowering from the end of June to late in August. Usually forming close colonies or compact groups.

Specimens examined:

Maine, St. Francis, St. John's River, Aug. 10, 1893. M. L. Fernald.

Canada, Notre Dame du Lac, Temiscouata Co. Aug. 6, 1887. John L. Northrop.

New York, near Elizabethtown, Essex Co. Sept. 5, 1892. N. L. Britton

" Tannersville, Green Co. Aug. 7, 1891. Miss Anna Murray Vail.

" White Plains, Westchester Co. Miss Phoebe McCabe.

Massachusetts, Lenox. July 11, 1889. W. M. Whitfield.

Pennsylvania, Lycoming Co. September 18, 1890. John K. Small and A. A. Heller.

West Virginia, Lone Tree Knob, Summit. C. F. Millspaugh, M. D. Flora of West Virginia, No. 450.

Montana, Belt Mountains, near Hound Creek. Aug. 2, 1883. F. Lamson Scribner.

Wyoming, Laramie Peak. Aug. 8, 1895. Aven Nelson. Flora of Wyoming, No. 1653.

I have also received the plant from Lewis and Ulster Counties, N. Y., and have collected it at York Harbor, Maine, the type locality, and in the Pocono region of Pennsylvana.

Type specimens from York Harbor are deposited in the Herbaria of Columbia University, and the New York Botanical Garden.

I take pleasure in naming this species in honor of Dr. N. L. Britton.

To anyone not having given particular attention to our species of *Agrimonia* it is altogether likely that this plant would pass unquestioned for *A. hirsuta*. It has more the general aspect of that species than of any other, the large fruit distinguishing it at once from *A. mollis*, with which in some respects it appears to have closer affinity. From *hirsuta* it may be readily distinguished by reference alone to its hoary pubescent racemes and darker green acuminate leaflets pubescent on the lower surface. It is less glandulose and aromatic than *hirsuta* and grows to be stouter and taller with straighter stem, stouter more ascending branches and longer more virgate racemes. The hairiness of the stem is also of a different character, being coarser and denser, with shorter, stiffer hair. The leaves are commonly narrower and less spreading, the thicker rugose-veiny leaflets more sharply serrate and acuminate with pubescent lower surface bearing brighter glandules and having the margins ciliolate instead of ciliate-fringed. Numerous specimens of *hirsuta* have failed to show any indications of incised bases of the lateral leaflets or a decurrent distal pair, or subleaflets in the position of stipels. The stipules of *A. Brittoniana* are narrower and more incised than those of *hirsuta*, and the bracteoles are notably unlike. The fruit, which is more crowded and closely reflexed, is of a different form, wanting the expanded marginal rim, tumid disk and contracted base characteristic of the fruit of *hirsuta* and, at maturity, presenting a signally diverse appearance from all our species by reason of the conical mass of connivent bristles.

From *A. mollis* the species differs in greater size, the stouter stem harshly hirsute instead of loosely villose or tomentose-pubescent, larger and thicker acuminate leaves provided with shining glandules on the lower surface and quite wanting the obovate or oblong figure and crenate or dentate margins of those of *mollis*, larger, more crowded flowers, much larger, more turbinate and deeply sulcate fruit having the bristles crowded and connivent instead of loosely ascending or erect.

The general character of the pubescence and branching of *A. Brittoniana* is much like that of *A. parviflora*, and the glandules beneath the leaflets present nearly the same appearance in both species. Other, if slighter, evidences of relationship between the two plants may also be noted, such as the sharply serrate often narrow leaflets of *Brittoniana*, the occasionally decurrent distal pair, the narrow and numerous subleaflets, the elongated racemes. These characteristics are more or less destinctive of *Brittoniana* among our species other than *parviflora*, in which they all find a more pronounced expression. The fruit of the two species is, however, remarkably different.

A. Brittoniana is in fact very distinct from any American species while nearly related to certain Asiatic forms—*A. viscidula* Bge., *A. pilosa* Ledeb. and *A. Dahurica* Willd., plants which have been variously confused together by authors, and all of which have finally been referred to *A. Eupatoria* L.

6. Agrimonia parviflora Soland.

Aromatic and glandulose, commonly $3\frac{1}{2}°$–$4\frac{1}{2}°$ tall ($1\frac{1}{2}°$ to over $6°$) virgate-branched above, the ascending branches simple or loosely few-branched and forming elongated strict racemes. Stem stout, becoming 4″–6″ thick below, papillose-roughened and densely hirsute with spreading brownish hair which conceals a fine surface pubescence and passes into a close hoary pubescence in the racemes; in immature plants the hairiness is very dense and subappressed, the young branches and racemes densely canescent-pilose. Leaves bright green, numerous, mostly spreading, but often the lower leaves are deflexed, those above spreading, the upper ones rapidly diminished in size and ascending or erect, mostly oblong to narrowly-oblong in general outline, 4′–12′ long, 2′–7½′ wide; leaflets commonly 11–17, or sometimes as many as twenty-three on the narrowed lowermost leaves, strongly-nerved and rugose, minutely petiolulate or sessile, spreading, the distal pair obliquely contiguous to the odd one and often decurrent on the leafstalk, the lower pairs frequently somewhat alternate, lanceolate, sometimes narrowly lanceolate, tapering to either end, acutely serrate, 1′–4¼′ long, 4″–14″ wide, a common size being 2½′ × 8″–9″, above obscurely hispidulous to glabrous, usually finely scabrous near the edges, the margins minutely ciliolate, paler below and thinly to softly pubescent, with longer appressed or spreading often brownish hairs on the nerves and sprinkled with minute shining glandules. Leafstalk villous, tomentose-pubescent on the upper side. Interposed leaflets crowded, mostly 4–5 pairs except in the lowest interspaces, often subopposite, mostly narrowly oblong and sessile by a broad base, the main pair sharply serrate to below the middle, separated by only a minute pair from the succeeding pair of leaflets, the others gradually smaller, all but the most minute sharply-toothed. Stipules, except the reduced lower ones, broadly cordate-amplexicaule, sometimes 1′ broad, the outer margin serrate or cut-serrate, deeply cleft at the tip into a narrow attenuate lobe sometimes 1′ long, which stands either abruptly erect against the stem or is bent sharply backward. Racemes glandulose beneath the pubescence, mostly erect or sharply ascending, 10′–21′ long, many-flowered. Flowers 3″–5″ broad, rather pale yellow with thin narrow petals; anthers small with broad connective. Bracts very small, pilose-pubescent, the lobes filiform; bracteoles very small, trifid. Flower-buds very small, somewhat obovoid and subtruncate, slightly mamillate, somewhat glandulose, sepals ovate-oblong, acute. Fruit small, nodding on slightly spreading pedicels, 1″–2″ wide and long, minutely glandulose; the slender stipe-like base slightly strigose, the body subglobose, short-turbinate or hemispheric below the bristles, the disk much elevated; bristles medial on the fruit, the outer short and reflexed, the innermost erect, equalling or exceeding the broad subtruncate calycular process. Base of the stem bulbous-thickened in the form of an oblong tuber sometimes nearly 1′ in diameter. Roots not tuberous-thickened.

Comes into flower from the middle to the end of July, continuing to bloom till about the middle of September.

This species is naturally a plant of low damp grounds and in such situations reaches its fullest development, commonly growing in scattered communities about the borders of weedy thickets. Occasionally it establishes itself in dry soil and becomes much reduced and quite distinct in appearance from the normal plant, though clearly nothing more than a dry ground state of the species. Extreme examples of this form are only 1½° tall and simple, terminating in a raceme 6′–8′ long; the leaves are much crowded, often reflexed and not larger than 3′–5′ long by 2′–2½′ wide; the small leaflets number only 3–5 pairs and are mostly elliptic and finely and sharply serrate, the subleaflets reduced in size and number and obovate, the stipules very small; on small sterile plants, the small leaflets may be oval and rather bluntly serrate and sometimes number only 2–3 pairs. (Plate 283, fig. 7.)

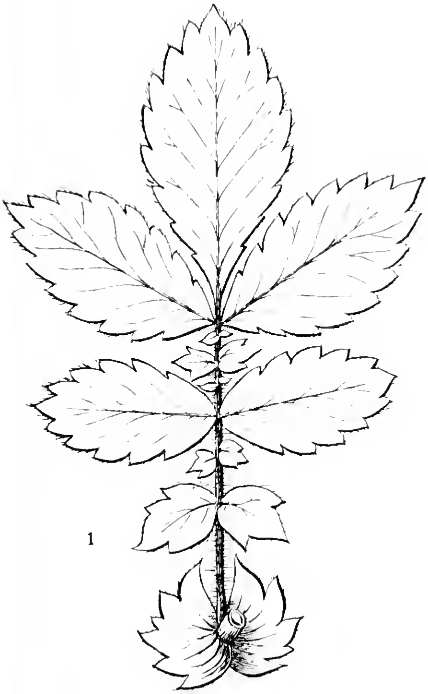
7. Agrimonia incisa T. & G.

From 1°–3½° tall, either simple, terminating in an elongated strict raceme, or bearing also ascending racemes from bracts or reduced leaves on the upper part of the stem. Stem clothed with a close soft-pubescence and villous with loosely spreading hairs which become subappressed and more pilose above and disappear in the pubescent and glandulose racemes. Leaves numerous, rather close and ascending, becoming gradually smaller and appressed above, narrowly-oblong or oblanceolate in general outline, 3′–6′ long, 1½′–2′ wide, the leafstalks tomentose-pubescent and villose. Leaflets thickish, prominently veiny, commonly 4–5 pairs, short, mostly oblong and ¾′ in length, 4″–7″ wide, sessile, or subpetiolulate, abruptly acute at base, rounded or acute at apex the odd one rather longer and with more narrowed base, acutely incised-serrate with few (3–6 on each side) salient, often slightly recurved teeth penicillate-haired from the apex, upper surface velvety, lower surface soft-pubescent and pilose-hairy, thickly covered with minute shining glands. Subleaflets a small 3-cleft pair in each interspace, with or without a minute entire pair on either side. Stipules narrowly laciniate-lobed, the terminal lobe longer, often cut on the inner side. Flowers rather large, rather loosely disposed on short subappressed pedicels; sepals elliptic; bracts and bracteoles very small. Fruit about 2″ long, 1″–1½″ wide, short-obovate or obconic with rather broad furrows, the numerous crowded bristles mostly marginal, ascending and erect, exceeding the broad obtuse calycular process. Roots not seen. (Plate 283, fig. 8.)

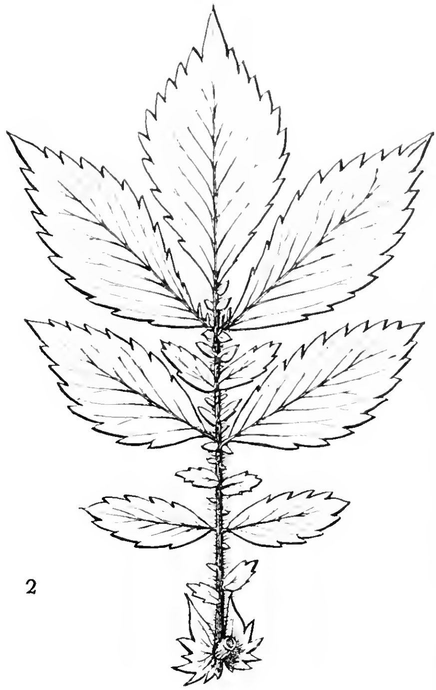
Dry pine woods, according to the label on one specimen.

Explanation of Plates 282 and 283.

Fig. 1. *Agrimonia hirsuta* (Muhl.).
" 2. " *Brittoniana* n. sp.
" 3. " *mollis* (T. & G.) Britton.
" 4. " *mollis* var.
" 5. " *pumila* Muhl.
" 6. " *striata* Michx.
" 7. " *parviflora* Soland.
" 8. " *incisa* T. & G.



1



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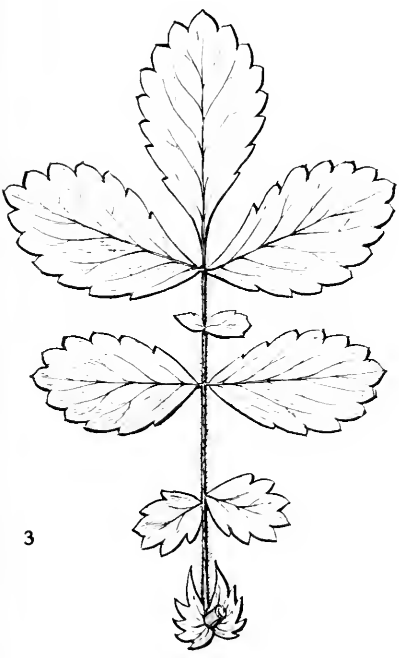

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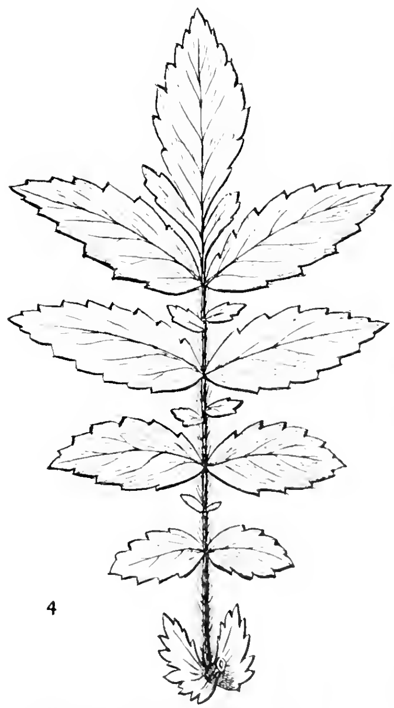


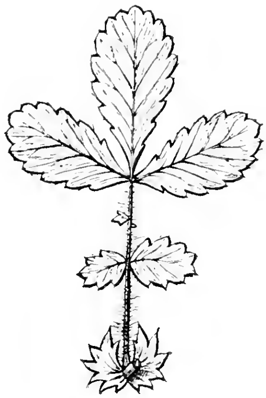
4

1. AGRIMONIA HIRSUTA MUHL.

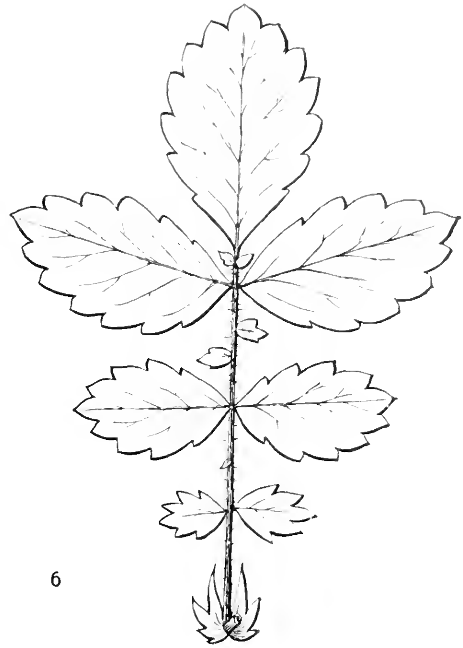
2. AGRIMONIA BRITTONIANA BICKNELL.

3. AGRIMONIA MOLLIS (T. & G.) BRITTON.

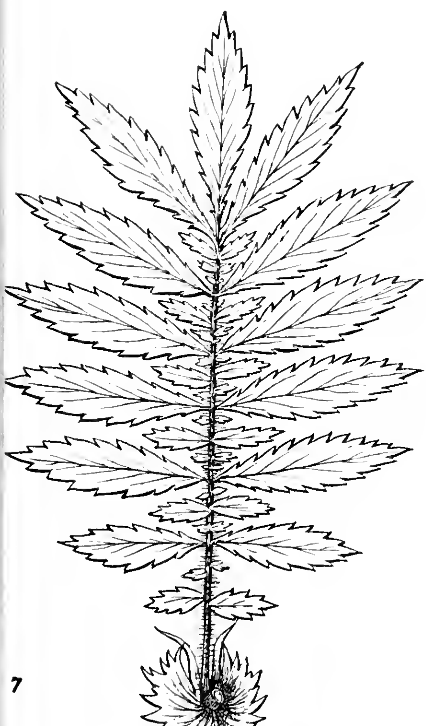
4. AGRIMONIA MOLLIS VAR.



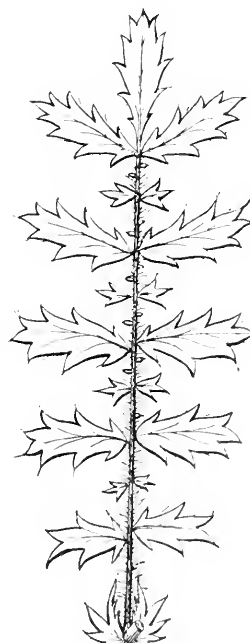
5



6



7



8

5. AGRIMONIA PUMILA MUHL.
7. AGRIMONIA PARVIFLORA SOLAND.
6. AGRIMONIA STRIATA MICHX.
8. AGRIMONIA INCISA T. & G.

Geum Canadense flavum (Porter) Britton, a valid species.

By Eugene P. Bicknell.

This plant is clearly an excellent species and should stand as *Geum flavum* (Porter). It is common in the vicinity of New York and shows itself to be perfectly distinct from its near relative, *Geum Canadense* Jacq., with which it is often found associated. Its points of difference from the latter are by no means confined to the size and color of the petals, but involve the pubescence, the form and texture of the leaves the branching of the inflorescence and other less obvious features. As these characters have never been pointed out, it may be useful to draw attention to them.

Geum flavum is much more coarsely pubescent below than *Canadense,* in which the basal petioles and lower part of the stem are often glabrate or only sparsely pubescent; in *flavum* the lower stem is hirsute-pubescent, often equally so with *Geum Virginianum* L., the leafstalks spreading-villose.

The leaves of *flavum* are mostly larger, thinner and duller green than in *Canadense,* often becoming very large and lax. The largest in specimens before me are 8′ long by 7′ wide on petioles 3′ in length, dimensions which greatly exceed anything seen in *Canadense.* The long-petioled basal leaves at flowering time are exceedingly multiform, varying from cordate-orbicular through trifoliate to pinnate with two or three pairs of leaflets, showing a much readier tendency to a pinnate form than those of *Canadense* and to the development of small subleaflets on the petiole. The lower cauline leaves reveal the same tendency to greater subdivision than those of *Canadense,* which are rarely other than trifoliolate or subpinnate. In *flavum* they are usually distinctly pinnate with 3–7 leaflets, the odd leaflet elongated and obliquely pinnatifid or pinnately-parted into oblong decurrent lobes; the lowest pair of leaflets are frequently also pinnatifid. In the trifoliolate stem-leaves of *flavum* the end leaflet is much longer relatively to the lateral ones than is the case in *Canadense*, and the simple upper leaves are mostly oblong or narrower with often obtuse basal lobes, usually in marked contrast with those of *Canadense*, which are rhombic-ovate or obovate and cuneate with acuminate or very acute lobes or angles mostly at or above the middle.

The dentition o the leaves in *flavum* is coarser than in *Canadense*, especially in the upper leaves, which are very coarsely dentate with irregular shallow teeth, in striking contrast with the much more finely and acutely dentate-serrate leaves of the latter.

The stipules of *flavum* are conspicuously larger than those of *Canadense* and variously incised and lobed; an extreme size is 1¾′ long by 1¼′ broad; the largest on specimens of *Canadense* now before me are 8″ x 4″. The pubescence of the leaves is in *flavum* coarser and looser than in *Canadense*, especially along the veins on the lower side of the basal leaves; it is much sparser on the upper leaves which are sometimes glabrate; in *Canadense* the leaves beneath are finely soft pubescent and velvety to the touch.

While *flavum* is generally more slender and weaker than *Canadense* this is not always true, except perhaps of the inflorescence, which is simpler and fewer-flowered with longer, more ascending branches and peduncles, the bracts often more foliaceous and sometimes entire.

The flowers of the two plants are always conspicuously different and constitute their most obvious distinctive character. In *flavum* the very small petals are cream-color or palest yellow and much shorter than the lobes of the calyx, 1″–1½″ long, ½″–1″ wide, linear-oblong or often broadened to the abrupt or truncate often retuse tip; in *Canadense* they are pure white, oblong or obovate, and two to four times as large (2″–4″ long, 1½″–3″ wide) equalling or exceeding the calyx-lobes. In both species the anthers show a shade more color than the petals. The flowers differ urther in the sepals, which in *Canadense* are more accuminate, and in the bractlets of the calyx, which are rather larger in *flavum*. In the latter the flowers are at first nodding; in *Canadense* they are erect or sometimes a little declined.

The fruit-heads of *flavum* are rather larger and more densely-fruited than in *Canadense* and usually paler green, and the mature achenes are slightly larger with longer slenderer beak. The receptacle is also longer and more cylindric, with coarser and stiffer tawny hair; in *Canadense* it is ovoid and clothed with longer and weaker white hair.

Geum flavum needs no close comparison with the very distinct *G. Virginianum*, although according to our text-books its flowers would refer it to the latter rather than to *Canadense*, and this very mistake appears to have been made in some of our local lists. It may be noted, therefore, that the flowers of *Virginianum* are considerably larger, especially the central carpellary portion; the creamy-white petals are larger, 2″–3″ long, 1½″–2″ wide and obovate-oblong, with revolute margins, thus often appearing linear. The pubescence of the stem in *Virginianum* is bristly-hairy throughout. In both *flavum* and *Canadense* the pubescence above is very fine and close, in the former often with longer scattered hairs.

Geum flavum comes into flower at New York from the end of June to the middle of July, one to three weeks later than *G. Canadense*, which begins to bloom, according to the season, from the second to the fourth week of June. *G. Virginianum* flowers still earlier, usually in the first week of June.

The latter is distinctively a plant of boggy ground. *G. Canadense* is the most generally scattered of the three species, occurring in damp or dry soil in woods and thickets and along roadsides. *G. flavum* is more solitary in its habits, and grows chiefly in rich, loose soil, in copses or upland woods, often among rocks.

The range of *G. flavum* appears to be much more restricted than that of *Canadense*. Prof. Porter has found it common at Easton, Pa., the type locality, and it is also common at New York. Elsewhere it seems to have been detected only in Lancaster county, Pa., and at Marion, Va., at an altitude of 2100 feet, by Dr. Small.

It is interesting to note that this species was known to Muhlenberg, who took it up in his 'Catalogue' as *G. Virginianum* L., naming the latter plant *G. hirsutum*, and distinguishing the two species by their different times of flowering.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 109.

Terminology among the Orders of Thallophytes.

BY LUCIEN MARCUS UNDERWOOD.

[Reprinted from THE BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 23, No. 12, Dec. 1896.]

Terminology among the Orders of Thallophytes.

BY LUCIEN MARCUS UNDERWOOD.

"To understand things in their proper relations is an important part of a student's education." In Botany, as in other subjects of extensive specialization, the student often fails to get the bearings of his subject, and in his presentation shows an utter lack of what may be called botanical perspective. One cause of this failure is the disposition, now happily growing less, to become botanists without knowing plants; without knowing them in their gross characters as well as their microscopic, in the field in their native haunts, as well as in the paraffin bath; in their natural environment as factors in a life-struggle for existence, as well as with only an environment of celloidin. We have had instances galore of young men without this perspective who have been skilled manipulators of microscopic machinery and little more, whose productions were studies without relations, complete and excellent in themselves, but without any recognized or recognizable bearings on botanical science. May we be protected from a prospective crop of graduates under the inflowing tide of physiological botany, which promises to be the next wave of the subject that sweeps the country, for of all men who do not know plants as a part of their preparation it seems as though the physiological botanist could be capable of the most harm of any.

A second reason why this lack of perspective is sometimes so apparent is the failure to grasp clearly the system of relations existing among the various groups of plants. This is partly the fault of those who present the subject, some of whom are the products of the extreme reaction against the old and meaningless method of study of botany; partly the fault of the makers of the systems themselves. It is of this last feature that I would speak at some length.

The average student, or even the brightest one, looking through a series of modern text-books, especially those treating of the lower plants, would probably be lost in a maze at the diverse systems of terminology and subdivision that are there presented, and if he saw signs of a real system among the various combinations proposed he would get at best an indistinct notion of relationships and coördinations. While nature does not draw many hard and fast lines, it is still possible to present in a somewhat simple manner a conspectus of the groups of living things she does develop. It is the purpose of this paper to suggest some methods in which these relations can be more satisfactorily presented to our students, with less possibility of giving them a confused conglomeration of unrelated categories.

In order to show more clearly the extent of this confusion I have selected for an illustration the group of the Ascomycetes, with particular notice of the allies of *Peziza*, and will show in parallel columns their arrangement in groups by some of the modern authors. I select this group for several reasons, among others the fact that it has been recently treated by several specialists in fungi, although most or all of them are naturally more or less influenced by the extensive researches of Brefeld. It is also a group that contains very diverse elements and permits of numberless combinations based on real or supposed relationships. (See table next page.)

Of the above statements of a system, that of Von Tafel, conservatively cautious and indefinite, is entirely silent on the group names; coördinate groups only are recognized and these may probably be taken as the conception of these relations held by Brefeld himself.

Rehm consistently uses the term " Familie " as subordinate to " Ordnung," but complicates his system by the introduction of two additional groups between order and family, " Hauptordnung " and " Unterordnung." His family names lack uniformity as seen in the examples *Exoasci*, *Dothidiaceae*, *Ascoboleae*. In fact the termination *-aceae* is used by him for groups of at least four different ranks, as: *Hysteriaceae* (Ordnung) *Pezizaceae* (Hauptordnung), *Sphaeriaceae* (Unterordnung), and *Hypocreaceae* (Familie).

Although Schroeter does not so characterize each group distinctively as "order" or " family;" their rank is clearly implied in the context and the termination *-aceae* is consistently used for the family. His ordinal groups, though mostly natural ones, lack uniformity and are often complicated in pronunciation, *e.g.*, Phacidiineae, Pyrenomycetineae, Hysteriineae.

*F. Von Tafel.**	*H. Rehm.*†	*J. Schroeter.*‡	*W. Zopf.*§	*S. H. Vines.*‖	*E. Warming.*¶
ASCOMYCETEN	3. Classe. ASCOMYCETES	II. ASCOMYCETES	Gruppe IV. ASCOMYCETEN	Sub-class 4. ASCOMYCETES	Sub-class ASCOMYCETES
Exoasci	1. Ord. Gymnoasceae	Hemiasceae	Ord. 1. Gymnoasceen	Ord. 1. Gymnoasceae	Series 1. Exoasci
Endomyceten	*Fam. Exoasci*	1. Hemiascineae	*Fam. 1. Saccharomyces*	Ord. 2. Pyrenomycetes	Series 2. Carpoasci
Taphrineen	*Fam. Gymnoasci*	Euasceae	*Fam. 2. Exoasci*	Sub-ord. Perisporiaceae	Fam. Gymnoascales
Carpoasci	2. Ord. Pyrenomycetes	2. Protoascineae	*Fam. 3. Gymnoasci*	Sub-ord. Tuberaceae	Fam. Perisporiales
Gymnoasceen	Unterord. Perisporiaceae	3. Protodiscineae	Ord. 2. Perisporiaceen	Sub-ord. Hypocreaceae	*Ord. Erysiphaceae*
Perisporiaceen.	*(2 families)*	4. Helvellineae	*Fam. 1. Erysipheen*	Sub-ord. Sphaeriaceae	*Ord. Perisporiaceae*
Erysipheen	Unterord. Hypocreaceae	5. Pezizineae	*Fam. 2. Aspergilleen*	Sub-ord. Dothidiaceae	*Ord. Tuberaceae*
Perisporieen	*Fam. Hypocreaceae*	*Pyrenemaceae*	*Fam. 3. Tuberaceen*	Ord. 3. Discomycetes	Fam. Pyrenomycetes
Tuberaceen	Unterord. Sphaeriaceae	*Pezizaceae*	Ord. 3. Sphaeriaceen	Sub-ord. Pezizaceae	Sub-fam. Hypocreales
Pyrenomyceten	*(18 families)*	*Ascobolaceae*	*Fam. 1. Sphaerieen*	*Fam. Phacidieae*	*Ord. Hypocreaceae*
Hypocreaceen	Unterord. Dothidiaceae	*Mollisiaceae*	*Fam. 2. Hypocreaceen*	*Fam. Pezizeae*	Sub-fam. Sphaeriales
Sphaeriaceen	*Fam. Dothidiaceae*	*Celidiaceae*	*Fam. 3. Xylarieen*	*Fam. Bulgarieae*	*(18 orders)*.
Dothideaceen	3. Ord. Hysteriaceae	*Patellariaceae*	*Fam. 4. Hysteriaceen*	"etc., etc."	Sub-fam. Dothideales
Hysteriaceen	4. Ord. Discomycetes	*Cenangiaceae*	Ord. 4. Discomycetes	Sub-ord. Helvellaceae	*Ord. Dothideaceae*
Discomyceten	1. Hauptord. Pezizaceae	*Cordieritidaceae*	*Fam. 1. Pezizaceen*		Fam. Hysteriales
Phacidiaceen	1. Unterord. Phacidiaceae	*Cyttariaceae*	*Fam. 2. Helvellaceen*		Fam. Discomycetes
Stictideen	2. " Stictideae	6. Phacidiineae			Sub-fam. Phacidiales
Tryblidiaceen	3. " Tryblidieae	7. Hysteriineae			Sub-fam. Stictidales
Dermateaceen	4. " Dermateaceae	8. Tuberineae			Sub-fam. Tryblidiales
Pezizaceen	5. " Pezizeae	8. Plectascineae			Sub-fam. Dermateales
Helotieen	*Fam. Mollisieae*	10. Pyrenomycetineae			Sub-fam. Pezizales
Mollisieen	*Fam. Helotieae*				*Ord. Helotiaceae*
Ascoboleen	*Fam. Eupezizeae*				*Ord. Mollisiaceae*
Pezizeen	*Fam. Ascoboleae*				*Ord. Pezizaceae*
Helvellaceen	2. Hauptord. Helvellaceae				*Ord. Ascobolaceae*
	Fam. Rhizineae				Fam. Helvellales
	Fam. Geoglosseae				*Ord. Helvellaceae*
	Fam. Helvelleae				
	5. Ord. Tuberaceae				
	Fam. Eutuberaceen				
	Fam. Balsamieen				
	Fam. Elaphomyceti-				
	neen				

* Vergleichende Morphologie der Pilze, 1892.
† Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. **1**: II., III., V., Abtheilung, 1884–1896 (Abt. V., by E. Fischer).
‡ Engler-Prantl. Die natürlichen Pflanzenfamilien. **1**: 142–224, 1894–1896. The portion after p. 178 continued by G. Lindau, who justly criticizes Schroeter's blunder of arrangement whereby the highest orders are sandwiched between lower ones.
§ Die Pilze in Schenk: Handbuch der Botanik. **4**: 271–755, 1890.
‖ A Student's Text-Book of Botany, 294–303, 1894.
¶ Haandbog i den Systematiske Botanik, 1892. (Translated by M. C. Potter, 1895, with revision of the Fungi, by Dr. E. Knoblauch).

The systems adopted by both Zopf and Vines are manifestly incomplete and are inserted simply to show the conspectus given in two standard works that have an extensive circulation in this country.

Warming's system is in some respects the most consistently carried out, but he introduces too many intermediate groups for clearness and most unaccountably makes the group *order* subordinate to *family* or even in some cases to *sub-family*. His group name *series* is not to be recommended for a group subordinate to a class.

The systems in use have thus been made confusing: (1) By lack of uniformity in terminations so that the relative rank of a group name cannot be told from its termination; (2) By confusing the usually accepted sequence of group names, so that the usual order of phylum (series), class, order and family is varied or even inverted; (3) By the use of numerous and confusing intermediate group-names which may be adapted to a monograph where details are entered into more minutely, but are out of place for presentation in a general way where clearness and simplicity ought to prevail; and finally, (4) By attempting to preserve old group names that no longer have a place in the system because they represent heterogeneous groups co rdinate with nothing now recognized.

It would seem that certain fundamental principles of terminology could be adopted that would vastly simplify the matter of a system of plants and, once in use, enable a student to more intelligently grasp the relationships of plants without subjecting him to this irregular and confusing terminology. Groups will change their limits with our increasing knowledge; new groups will appear and the system of relationships be modified with each generation, but a set form of expression once adopted might become as easy of comprehension as the simple principle involved in binomial nomeclature. Among the features of such a form of expression are:

1. The two group names above the genus should be definitely fixed and their sequence rigidly maintained. The termination *aceae* should be reserved for families in accordance with well known and long existing usage among the higher plants. To

make this termination significant every time, it should appear nowhere in the system outside of family names.

2. For the ordinal name no termination could be better than that of *-ales*.* Long usage as a "Cohort" name, simplicity of affixing and pronunciation, clearness and brevity, all recommend it. If used it ought to be used *exclusively* for orders; it would then characterize at sight the rank of the group name as the termination *-idae* does the family in zoölogy.

3. The names should as far as possible be affixed to the names of representative genera or, if not, be derived from some striking characteristic or feature of the group. Family names, for obvious reasons, should always be of the former class.

4. Miscellaneous group names need not be retained after their usefulness in the system ceases to exist. Where an older name occurs which is practically an order, in the modern sense, it is desirable, where simplicity can be preserved, to so modify the old name as to conform in termination with the new system, but the rules of priority accepted for genera and species need not necessarily apply to either family or ordinal names. It would seem better to attain uniformity of usage by other means.

As a further means of illustrating this simplicity I append the ordinal groups that I am accustomed to use in presenting the relationships of the fungi to students. Nothing is claimed for it except an adaptation of the principles above recommended to the system believed to be nearest in accord with modern research.†

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* Compare the discussion of this subject, this journal, 22: 124–129. It is only fair to state that when that paper on the classification of the Archegoniates was written I had not seen Engler's *Syllabus der Vorlesungen*, which contains certain divisions similar to those suggested in my paper and necessarily antedating it. He uses the same termination *-ales* for orders, but not uniformly, nor exclusively for groups of that rank.

† At present I am using the following presentation of the leading groups of Algae:

Class BACILLARIAE—with one order: DIATOMALES

Class CYANOPHYCEAE—with 4 orders: CHROOCOCCALES, OSCILLARIALES, NOSTOCALES, SCYTONEMALES.

Class CHLOROPHYCEAE—with 6 orders: PROTOCOCCALES, CONJUGALES, SIPHONALES, CONFERVALES, COLEOCHAETALES, CHARALES.

Class PHAEOPHYCEAE—with 3 orders: PHAEOSPORALES, DICTYOTALES, FUCALES.

Class RHODOPHYCEAE—with 5 orders: BANGIALES, NEMALIONALES, CRYPTONEMIALES, GIGARTINALES, RHODYMENIALES.

Series FUNGI of the Phylum THALLOPHYTA.

Class PHYCOMYCETES (Algal-fungi).*

- Order CHYTRIDIALES. (Algal parasites).
- Order MUCORALES. (Moulds).
- Order ENTOMOPHTHORALES. (Insect parasites.)
- Order SAPROLEGNIALES. (Aquatic moulds.)
- Order PERONOSPORALES. (Downy mildews.)

Class ASCOMYCETES. (Spore-sac fungi.)

- Order HEMIASCALES.
- Order PROTOASCALES. (Yeast fungi.)
- Order GYMNOASCALES. (Plum pockets.)
- Order PERISPORIALES. (Powdery mildews, etc.)
- Order HYPOCREALES.†
- Order SPHAERIALES. } Black-fungi (Pyrenomycetes).
- Order DOTHIDEALES. }
- Order LABOULBENIALES ‡
- Order TUBERALES. (Truffles.)
- Order HYSTERIALES.
- Order PHACIDIALES. } Cup-fungi (Discomycetes).
- Order PEZIZALES. }
- Order HELVELLALES. (Morels, etc.)

(Fungi Imperfecti.)§

- Order HYPHALES. (Hyphomycetes.)
- Order MELANCONIALES.
- Order SPHAEROPSIDALES. (Spot fungi.)

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* Fischer's arrangement of these forms in the order of their simplicity of reproduction and structure seems highly satisfactory. The first order forms the sub-class *Archimycetes*, with usually asexual methods of reproduction. The second and third form the *Zygomycetes*, their sexual reproduction being by conjugation. The last two orders form the *Oomycetes* in which sexual reproduction is sufficiently differentiated, so that the egg forms the passive as the antherid forms the active element.

† It is with some misgivings that this group is left as a coördinate group with the next, since it differs from it chiefly in the color and consistency of the stroma.

‡ This remarkable group, whose development is one of the triumphs of American botany, is surely worthy of ordinal rank. It is remarkable that only one of the authors quoted, mentions this extensive group, and then only as an "Anhang" to the Pyrenomycetes. And still there are Germaniacs among American botanists who continue to claim that American botany is nothing.

§ This unfortunate group is the *bête noir* of the systematist. That some of these forms are not now connected with any ascigerous form is certain. That a considerable number of them have always had a complete autonomy is highly probable.

Class BASIDIOMYCETES.

Order USTILAGINALES. (Smuts.)

Order UREDINALES. (Rusts.)

Order TREMELLALES. (Gelatinous fungi.)

Order HYMENIALES. (Mushrooms, etc.)

Order GASTRALES. (Puff balls, etc.)

In case the slime moulds and Bacteria are not to be relegated to the domain of animal life, as has been time and again suggested, they would properly form classes lower than the Phycomycetes, *viz.*: MYXOMYCETES with the Order Acrasiales, Plasmodiophorales and Myxogastrales; and SCHIZOMYCETES with the Orders Eubacteriales and Myxobacteriales. *

There still remains the systematic position of the Lichens. Since the coördination of the orders of the entire phylum Thallophyta is far from being settled owing to the limitations of our knowledge, and since the two main series, separated from each other by physiological rather than structural or morphological characters, are held apart largely as a matter of convenience, it may be better to likewise hold the lichens apart as a separate group, though the reasons therefor are much less apparent than in the separation of the algae and the fungi. The lichens are distinctively fungi and there is no more real reason for holding them apart from the fungous orders with which they intergrade than there would be in separating other parasitic forms in distinct series because of some supposed mutualism between the parasite and its host. The fact that the lichens have been treated apart from their real alliances has doubtless been the cause of some part of the confusion relating to them. The orders Pyrenolichenales, Discolichenales, Hymenolichenales and Gastrolichenales may therefore be sandwiched in among their nearest alliances in the conspectus. If held apart in a distinct series it must be understood as a matter of expediency and convenience and not an indication of natural affinity among diverse groups such as they really are.

9 DECEMBER, 1896.

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* Cf. Thaxter, Bot. Gazette, 17: 389–406. D 1892.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 110.

Notes on Potentilla.—VI.

(PLATES 287, 288.)

BY P. A. RYDBERG.

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Notes on Potentilla.—VI.

By P. A. Rydberg.

(Plates 287, 288.)

The *Hippianae* constitute a group somewhat related to the *Multijugae*. They are, however, as a rule stouter than the members of that group, and the leaves are more or less white or grayish hairy, generally densely silky, villous or tomentose. The group contains the following species :

Potentilla Breweri S. Wats. Proc. Am. Acad. 7 : 555. 1873.

Potentilla Breweri much resembles *P. Plattensis*. It has the large stipules characteristic of that species and also essentially the the same flowers. The leaflets are, however, broader and less divided and densely silky-villous. In the typical form the cyme is rather dense and the flowers larger. It grows in California.

Potentilla Breweri expansa S. Wats. Bot. Cal. 1 : 179. 1876.

Potentilla Plattensis leucophylla Greene, Erythea, 1 : 4. 1893.

This resembles *P. Plattensis* still more, having the open cyme of that species. It grows also in Nevada and is apparently more common than the species.

Potentilla crinita A. Gray, Mem. Am. Acad. 1849 : 41. 1849.

This is of similar habit but easily distinguished by its conduplicate, appressed-silky cuneate leaflets, which are slightly crenate at the apex. *P. crinita* grows on the dry plains of Arizona, New Mexico, southern Utah and Colorado.

Potentilla effusa Dougl.; Lehm. Stirp. Pug. **2**: 8. 1830.

The pubescence is grayish or whitish tomentose, not at all silky; the branches are rather divergent and the bractlets much smaller than the acuminate sepals. It grows on the dry plains from New Mexico to Montana, Assiniboia and Minnesota (?).

Potentilla effusa gossypina Nutt.; Torr & Gray, Fl. N. Am. **1**: 437. 1840, is still unknown. Dr. Hooker, in London Jour. Bot. **6**: 219, states that the plant collected by Geyer (no. 637) was labelled by Nuttall *P. gossypina*. These specimens Dr. Hooker identified as *P. arachnoidea* Douglas, which is *P. Pennsylvanica arachnoidea* Lehm.

Potentilla filicaulis (Nutt.).

Potentilla effusa filicaulis Nutt.; Torr. & Gray, Fl. N. Am. **1**: 437. 1840.

This is known from only two fragmentary specimens, one, the original of Nuttall, in the Torrey Herbarium at Columbia University, the other collected by Dr. J. M. Coulter, in 1872, near Fort Hale, and preserved in Dr. Porter's private collection. The stem is very slender, filiform. As the pubescence is somewhat silky, it is probably more related to the following species:*

Potentilla Hippiana Lehm. Stirp. Pug. **2**: 7. 1830.

Potentilla leucophylla Torr. Ann. Lyc. Nat. Hist. N. Y. **2**: 197. 1827. Not Pallas.

Potentilla leneophylla Eat. Man. Ed. 5, 344. 1829.

The name used by Eaton seems to have been overlooked altogether. It may be claimed that the name given was only a misprint for *P. leucophylla*, the original name, which, however, is antedated by *P. leucophylla* Pallas, a synonym of *P. nivea*. The name *P. leneophylla*, which means woolly-leaved, a very appropriate name, is not only found in the fifth edition of Eaton's Manual, but also in the sixth and seventh editions and in Eaton & Wright's North

* Since the above was written I have found a sheet of good specimens in a collection from the Iowa Agricultural College at Ames. These specimens show that the plant is more nearly related to *P. Hippiana* than to *P. effusa*, having practically the same pubescence and sepals as that species, but is much smaller. It has often subdigitate leaves, and holds about the same relation to *P. Hippiana* as *P. saximontana* and *P. minutifolia* do to *P. pulcherrima*, and may better be referred to the *Subjugae* group.

American Botany. Watson in his Bibliographical Index has no reference to any of the editions of Eaton's Manual and gives Eaton & Wright as a reference under *P. leucophylla*, which does not appear there. The Kew Index has also omitted *P. leucophylla*, which should take the place of *P. Hippiana*, being a year older, if it were not for the fact that it very likely is to be explained as a misprint. *P. Hippiana* is sometimes very hard to distinguish from *P. effusa*, and the two seem to grade into each other. *P. Hippiana* is, however, as a rule larger, silky as well as tomentose; the branches are more erect and the bractlets nearly equalling the acute sepals. The species grows on the plains and the foot hills of the Rockies, but generally in richer soil than *P. effusa*. It extends from New Mexico and Arizona to Minnesota and Saskatchewan.

POTENTILLA HIPPIANA PROPINQUA n. n.

Potentilla diffusa A. Gray, Mem. Am. Acad. **1849**: 41. 1849. Not Willd.

Potentilla Hippiana pulcherrima S. Wats. Proc. Am. Acad. 555, in part, 1873. Not *P. pulcherrima* Lehm.

The stem is more diffuse or ascending, rather low; the leaflets are more approximate and more silky, scarcely at all tomentose, often green above. In the latter case they resemble somewhat those of *P. pulcherrima*, which is a much taller plant.

POTENTILLA AMBIGENS Greene, Erythea, 1: 4. 1893.

It is strange that this very marked species should not have been described before 1893. It was collected by Hall and Harbour in 1862, Wm. A. Bell in 1867 and Geo. Vasey in 1881. The first specimens were included by Dr. Gray in *P. Hippiana*. On the label of Bell's specimens is written: "Durand suggests *P. rivularis*. Gray says no!—perhaps *P. campestris*." One of Dr. Vasey's specimens is labeled *Potentilla Thurberi*, by whom I do not know.

P. ambigens is the tallest of the group, 6–7 dm. high, rather sparingly grayish silky. The leaflets are 3–4 cm. long, coarsely serrate and more or less decurrent on the rachis. The following specimens have been examined:

Colorado: Hall & Harbour, nos. 158 and 162, 1862 (both only in part); E. L. Greene.

New Mexico: Wm. A. Bell (Ratan Mountains), 1867; G. R. Vasey (Las Vegas), 1867.

POTENTILLA LEMMONI (Wats.) Greene, Pittonia, **1**: 104, 1887.

Ivesia Lemmoni Wats. Proc. Am. Acad. **20**: 365. 1885.

This species should, I think, be placed as an appendix to this group. It has no relationship to any of the Ivesias, and is a true Potentilla in every respect, except as to the number of pistils, which are only half a dozen or so. Its nearest relative is, without doubt, *Potentilla crinita*, from which it differs by the longer, narrower and fewer leaflets, the sparser pubescence, the few pistils and the longer hairs on the receptacle.

Graciles. This group is the most difficult in the whole genus. It contains so many and perplexing forms, that I have not yet come to any definite conclusion as to how to treat it. Watson united all except the first (partly) and the last into one species. This is far from satisfactory. It would have been much more logical to make *P. effusa* a variety of *P. Hippiana*, *P. Breweri* one of *P. Plattensis*, or *P. emarginata* one of *P. fragiformis* than to include *P. Nuttallii* and *P. flabelliformis* in *P. gracilis.* The group contains not less than ten well marked American forms and about half a dozen less marked ones. Of these ten forms all except one have been recognized at one time or another as species or varieties, and as far as I know, all but two have received names. I shall temporarily regard these ten as species.

This view I dare to express, as I have had chance to study this group especially in the field. I have collected the following myself: *P. pulcherrima*, *Blaschkeana*, *flabelliformis*, var. *ctenophora*, *fastigiata*, *ctomentosa and Nuttallii.* I have seen the following growing together: *pulcherrima* and *Nuttallii*, *Blaschkeana* and *Nuttallii*, *Blaschkeana* and *flabelliformis*, *Blaschkeana* and *ctenophora*, *flabelliformis* and *Nuttallii.* In no case have I found intermediate forms. In the herbaria that I have looked over I have found one specimen between *Blaschkeana* and *ctenophora*, a few between *Nuttallii* and *Blaschkeana* or *fastigiata*, etc., but as a rule they can be distinguished fairly well.

POTENTILLA PULCHERRIMA Lehm. Stirp. Pug. 2: 10. 1830.

Potentilla Hippiana pulcherrima Wats. Proc. Am. Acad. 7: 555. (in part) 1873.

As originally described, *P. pulcherrima* Lehm. has pinnate leaves with approximate leaflets. This was undoubtedly the reason why Watson united it with *P. diffusa* Gray. As far as I know, that plant is low, ascending, and rather silky and in all respects nearest related to *P. Hippiana* (see above), while *P. pulcherrima* is tall, upright, with slender erect branches and nearest related to *P. gracilis* and *P. fastigiata*. Watson, during King's expedition, observed the fact that *P. pulcherrima* had not always pinnate leaves, which, in fact, is rather seldom the case, and consequently included in *P. Hippiana pulcherrima* also a form with digitate leaves. The only character left to distinguish forms of *P. Hippiana* and those of *P. gracilis* was the number of carpels, in the former 10–30, in the latter 40. Unfortunately the number varies even in the same individual, and therefore many specimens labelled *P. gracilis* belong to *P. pulcherrima*. My own from the Black Hills, I unfortunately labeled thus. *P. pulcherrima* differs from the other members of the group by its leaflets, which are obovate or oblanceolate, mostly obtuse, crenate, silky and green above, densely white-tomentose beneath. It grows in the mountains and foot hills from New Mexico and Nevada to Saskatchewan. No specimens have been seen from the Pacific Slope.

POTENTILLLA GRACILIS Dougl.; Hook. Bot. Mag. *pl. 2984*. 1829.

The true *P. gracilis* is a very rare plant and confined to the northern Pacific Coast. What has gone under this name is either the preceding or the next following species. It differs from both in the narrow leaflets, which are oblanceolate, acute, and coarsely toothed with triangular teeth of the same form as in *P. recta*. The leaves are only slightly silky above and finely tomentose beneath, and the branches of the cyme are very slender and erect. The following specimens have been examined:

Oregon: Douglas; Tolmie, 1851; E. Hall, no. 136, 1871. *Washington:* Dr. Ruhn; Wilke's Expedition, no. 141. *Vancouver Island:* John Macoun, no. 182, 1893. *Kodiak Island:* (Collector not given).

POTENTILLA BLASCHKEANA Turcz; Lehm. in Otto, Gart. & Blumenz. 9: 506. 1853.

Potentilla gracilis most authors, not Dougl.

This differs from *P. gracilis* in stouter habit, ascending branches, larger flowers and broader leaflets, which are obovate, deeply toothed or cleft into ovate or oblong teeth, silky and green above, silky and tomentose beneath. It must be admitted that this species is near to the preceding. It was merged therein by Watson, but it is evidently not so near *P. gracilis* as is *P. pulcherrima*, which differ only in the form of the teeth.

P. Blaschkeana is common from California to Wyoming and northward as far as Kodiak, off Alaska.

POTENTILLA CANDIDA n. sp.

Potentilla gracilis var. Wats. King's Exp. 5: 88. 1871.

Stem low, 1–2 dm. high, densely white silky-strigose; stipules ovate, entire, nearly 1 cm. long; leaves on rather short petioles, densely silvery silky on both sides, digitate; leaflets 7–9, obovate in outline, 2–4 cm. long, rather thick, deeply incised or cleft into large oblong teeth; cyme rather dense; flowers about 1 cm. in diameter; calyx white-silky; bractlets lanceolate, much shorter than the ovate sepals; petals yellow, obcordate, a little exceeding the sepals. (Plate 287.)

It resembles most a depauperate *P. Blaschkeana*, and differs mainly in the pubescence which is very dense on both sides of the leaves, and silky; tomentum none.

Nevada: S. Watson, no. 337, 1868 (type). *Montana:* F. V. Hayden, 1860. *Wyoming:* T. C. Porter, 1873.

POTENTILLA FLABELLIFORMIS Lehm. Stirp. Pug. 2: 12. 1830.

Potentilla gracilis flabelliformis Nutt.; Torr & Gray, Fl. N. Am. 1: 440. 1840.

This stands nearest to *P. Blaschkeana*, but I think it is without doubt a good species. I have had the opportunity to watch the two in the field and found them often grow together, but never found an intermediate form, and in all the collections that have gone through my hands there are only the specimens from one locality, where I am in doubt to which species to refer them, and these may be hybrids. *P. flabelliformis* differs from the related species in the leaves, which are divided to near the base into linear segments. They are also white-tomentose beneath and densely silky above. There are two forms of this species; the one with narrow linear more or less revolute lobes and smaller flowers resembles Lehmann's figure in Hooker's Fl. Bor. Am., and is therefore taken as the type. The other somewhat approaches *P. Blaschkeana* in the general habit and the size of the flowers, and may be known under the name:

POTENTILLA FLABELLIFORMIS CTENOPHORA n. v.

Stem stout; leaflets less deeply divided into somewhat broader divisions, which are not at all revolute. Corolla over 15 mm. in diameter, petals broadly obcordate, much longer than the sepals.

Both forms are fairly common from Wyoming and California to British Columbia and Saskatchewan.

POTENTILLA FASTIGIATA Nutt.; Torr. & Gray, Fl. N. Am. 1: 440. 1840.

Potentilla gracilis fastigiata Wats. Proc. Am. Acad. 7: 557. 1873.

This perhaps comes nearest to *P. pulcherrima*, resembling it in the form of the leaflets and the size of the flower, but it is a smaller plant, less than 3 dm. high and with a rather crowded cyme. The pubescence of the leaves is also different, long, silky and with very little tomentum beneath. It is a rather rare plant, extending from Wyoming and California to British Columbia and Saskatchewan.

POTENTILLA PECTINISECTA n. sp.

Stem slender, 3–4 dm. high, ascending, finely strigose or hirsute; stipules ovate, often toothed; leaves on slender petioles, digitate, of 5–8 leaflets, apressed-silky on both sides and sometimes slightly tomentulose beneath; leaflets obovate, deeply pectinately divided into oblong or linear segments; cyme rather dense; calyx appressed-silky; bractlets linear-lanceolate, shorter than the broadly lanceolate sepals; petals yellow, obcordate, scarcely exceeding the sepals.

It has gone under the names of *P. gracilis flabelliformis* and *fastigiata*. It resembles *P. fastigiata* in general habit and pubescence, but is more slender. The form of the leaflets is most like that of *P. Blaschkeana* and *P. Nuttallii*, and sometimes that of *P.*

flabelliformis, but the plant is more delicate and the pubescence is silky and rather scant. Specimens:

Arizona: E. Palmer, no. 145, 1877. *Wyoming:* C. E. Sheldon, no. 72, 1884; Fremont, 2d exp. *Montana:* Robert Adams, 1871. *Utah:* L. F. Ward, no. 119, 1875; M. E. Jones, no. 5554d and 35544, 1894; no. 765, 1880; Mrs. Thompson, no. 195, 1873.

POTENTILLA ETOMENTOSA n. sp.

Potentilla rigida Newberry, Pac. R. R. Rep. **6**: Part 3. 72. Not Nutt.

Potentilla gracilis rigida Coville, Cont. U. S. Nat. Herb. **4**: 96. 1893.

Stem 4–5 dm. high, slightly hairy, erect, from a stout caudex; stipules ovate, lanceolate, entire; leaves on long petioles, digitate, of about 7 leaflets, glabrate above, slightly silky-strigose beneath but without any trace of tomentum; leaflets obovate, 3–5 cm. long, crenate or serrate with ovate teeth; calyx hirsute; bractlets oblong, a little shorter than the ovate pointed sepals; petals obcordate, scarcely exceeding the sepals.

This resembles mostly *P. pulcherrima* but is perfectly without tomentum and only slightly hairy. It resembles *P. Nuttallii* only in the lack of tomentum. It has the crenate, obovate leaves of *P. pulcherrima*, and if not held distinct must be regarded as a variety thereof. The distribution is quite different, *P. pulcherrima* not having been collected in California. The following are the specimens seen:

California: Fremont, no. 162, 1846 (Type); J. S. Newberry (Williamson Expedition); Munson & Hopkins, 1889; Coville & Funston, no. 1399, 1891.

POTENTILLA NUTTALLII Lehm. Ind. Sem. Hort. Bot. Hamb. **1852**: 12. 1852.

Potentilla recta Nutt. Gen. **1**: 310. 1818. Not L.

Potentilla rigida Nutt. Journ. Acad. Phila. **7**: 20. 1834. Not Wall.

Potentilla gracilis rigida Wats. Proc. Am. Acad. **7**: 557. 1873.

The general habit of this species resembles that of *P. Blaschkeana*, but the plant is green, without tomentum and coasely hirsute. The distribution is from Colorado to California, British Columbia and Saskatchewan.

POTENTILLA RECTA L. Sp. Pl. 497. 1753.

It somewhat resembles *P. Nuttallii* in pubescence and general habit, but differs in being paler and in its large pale yellow petals. It is of European origin and occurs sparingly in the Eastern States to the District of Columbia and to Ohio.

The *Argenteae* resemble in general habit the preceding group The plants are very leafy, the leaflets generally 5 or those of the upper leaves only 3, the flowers many and small, and the petals scarcely exceed the sepals. The group is European, only *P. argentea* being also a native of North America.

POTENTILLA INTERMEDIA L. Mant. 1: 76. 1767.

This species very much resembles *P. Monspeliensis*, especially var. *Norvegica*, and has in this country been mistaken for it It differs mainly in the mostly 5-foliolate leaves, the perennial root and the style. The species is sparingly introduced in the East. Some of the specimens are:

New Jersey and *New York:* Addison Brown, 1881 and 1880.

POTENTILLA INCLINATA Vill. Hist. Pl. Delph. 3: 567. 1789.

P. canescens Besser, Prim. Fl. Galic. 1: 330. 1809.

It much resembles the preceding species, but differs in a more slender and simple stem and the grayish pubescence. The only specimens collected on this continent that I have seen are those collected in Ontario by Fowler.

POTENTILLA ARGENTEA L. Sp. Pl., 497. 1753.

P. argentea is one of the easiest to identify, by its small flowers, deeply dissected leaves, which are white-tomentose, especially beneath, and have revolute margins. It is a native of Europe and Asia, as well as of America. In this country it extends from Nova Scotia and the District of Columbia to Dakota and Kansas.

POTENTILLA COLLINA Wibel, Prim. Fl. Werth., 267. 1799.

This is another species that has been collected in the country at least once, viz., by J. M. Holzinger (no. 30) at Winona, Minn., in 1887. It differs from *P. argentea*, which it most resembles, by its prostrate or spreading habit, less white-tomentose leaves, which have broader lobes, and flat, not revolute margins.

The *Tormentillae* are a small group, characterized by the more or less spreading, prostrate or creeping stem and long-pedicelled, axillary flowers. The original *Tormentillae* have 4-merous flowers, but sometimes, however, they are 5-merous, and other species that have regularly 5-merous flowers have no other character which would warrant the division into two groups, much less into two genera. The group is mainly European, only one species being a native of North America, viz.:

POTENTILLA CANADENSIS L. Sp. Pl. 498. 1753.

It is a very variable plant, and several species have been proposed. What I take as the original *P. Canadensis* is a less luxuriant form of what has generally been known as *P. Canadensis simplex* (Michx.) T. & G. (*P. simplex* Michx.), not that small, simple, more hairy form, only a few inches high, that grows in poor dry soil, which is

POTENTILLA CANADENSIS PUMILA (Poir.) T. & G. Fl. N. Am. 1: 443. 1840.

Potentilla pumila Poir. in Lam. Enc. Meth. 5: 594. 1804.

P. Canadensis is common from Maine and North Carolina to Indian Territory and Minnesota. I have seen one specimen collected in Nevada, but this was undoubtedly introduced. The variety has about the same range, but is rarer.

POTENTILLA REPTANS L. Sp. Pl. 499. 1753.

This European species has been collected by Martindale in 1876 on ballast in New Jersey. It differs from *P. Canadensis* in the creeping and rooting stem, smaller leaves and large, ovate or elliptical bractlets, which exceed the sepals.

POTENTILLA NEMORALIS Nestler, Mon. Pot. 28 and 65. 1816.

Tormentilla reptans L. Sp. Pl. 500. 1753. Not *Potentilla reptans* L.

Also a European species which has been collected in Labrador. It differs from *P. Canadensis* in the 4-merous flowers and in the leaves, which are all, except the basal ones, ternate.

Haematochri. The dark purple- or dark red-flowered species of *Potentilla* constitute a very natural group, which consist of the

Mexican species: *P. Ehrenbergiana*, *Haematochrus*, *fusca*, and *comarioides*, a few Indian species, as for instance *P. Nepalensis* and *P. atrosanguinea*, and two species of the Southwestern United States, viz.:

POTENTILLA THURBERI A. Gray, Mem. Am. Acad. (II.) 5: 318. 1854.

As described by Gray and Lehmann, *P. Thurberi* should be perfectly green and only slightly hairy. Such specimens have been collected as follows:

New Mexico: Thurber, no. 1107, 1851; Dr. Henry, 1854; Dr. Bigelow (Mex. Bound. Surv.), no. 347, 1851; E. L. Greene, 1880; E. Palmer, 1869. *Arizona:* Lemmon, 1881; C. G. Pringle, 1884; Wooton, 1895.

More than half of the specimens in our collections that are labelled *P. Thurberi* do not agree with the original description, and I take them to represent an undescribed species:

POTENTILLA ATRORUBENS.

Potentilla Thurberi Rothrock, Wheeler Surv. 4: 113. (mainly.) 1878.

Stem 4–7 dm. high, finely pubescent and with scattered long villous spreading or reflexed hairs; stipules ovate or lanceolate, 1–2 cm. long, often toothed; basal and lower stem-leaves long-petioled, digitately 5–7-foliolate, glabrous or slightly silky above, silky and white-tomentose beneath; leaflets obovate to oblanceolate, coarsely serrate; stem-leaves sessile, 3–5-foliolate; cyme open and branched; flowers about 15 mm. in diameter; calyx silky-villous and finely pubescent, about 1 cm. in diameter; bractlets lanceolate, often equalling the lanceolate-triangular, more or less acuminate sepals; petals dark reddish purple, very broadly obcordate, exceeding the sepals; stamens 20. (Plate 288.)

This species much resembles *P. Thurberi*, from which it has not been distinguished. It differs, however, in several characters that seem to be fairly constant, viz., the tomentum on the lower surface of the leaves, the much sharper dentation, the long silky spreading or reflexed hairs of the stem and calyx, and generally more acuminate sepals. From the Mexican *P. fusca* and *P. comarioides* it differs in the leaflets, which are serrate to the very base. It seems to be more common than *P. Thurberi* and has about the same range.

Arizona: Rothrock, no. 399, 1874; C. G. Pringle, no. 305, 1881; 1884; no. 1,578, 1887; M. E. Jones, 1884; J. G. Lemmon, no. 2699, 1882; 1892; E. A. Mearns, no. 50, 1887; T. E. Wilcox. 1893. *New Mexico:* H. H. Rusby, no. 128, 1881.

The *Argentinae* are a natural group, perhaps worth generic rank. The plant is propagated by true runners as in *Fragaria.* The style is lateral as in that genus and the achene large with thick corky shell. These characters are not found in any other species of *Potentilla*, at least not in America. All the species belonging here have pinnate leaves more or less white silky, at least beneath. The species of the group are *P. anserinoides* of New Zealand and the following:

POTENTILLA ANSERINA L. Sp. Pl. 495. 1753.

This well known species is found in the colder part of the north temperate and the arctic zones of both hemispheres, extending in North America as far south as New Jersey and Nebraska, and in the mountains to New Mexico. The following varieties may be distinguished:

POTENTILLA ANSERINA GRANDIS Torr & Gray, Fl. N. Am. 1: 444. 1840.

A luxuriant form growing among grass, with larger, erect or ascending leaves, sometimes one foot long. It is common on the Pacific coast from California to Alaska, but also collected in Montana, Newfoundland and Greenland.

POTENTILLA ANSERINA CONCOLOR Ser. in DC. Prod. 2: 582. 1825.

It differs from the species in the leaves, which are silky white on both the upper and lower surfaces. In America it is confined to the Rocky Mountain Region from Mackenzie River to New Mexico, California and Alaska.

POTENTILLA EGEDII Wormsk. Fl. Dan. 9: fasc. 27. 5.

Potentilla Anserina Egedii Torr. & Gray, Fl. N. Am. 1: 444. 1840.

Potentilla Anserina Groenlandica Tratt. Ros. Mon. 4: no. 13. 1824.

I think that this is a good species, differing from *P. Anserina* in the delicate habit, the deeper and more open incisions of the leaflets and the scant pubescence. In the specimens examined by me the achenes were also different in shape. In *P. Egedii* they were decidedly lenticular, while in *P. Anserina* the upper end is thicker and rounded-triangular in cross-section.

P. Egedii is an arctic species, found from Greenland to Alaska, and extending southward on the coasts to Maine and Oregon.

The *Fruticosae* differ from the other groups of North American *Potentillae* in the following respects: The style is lateral, ovule ascending, achene hairy and the plant more or less shrubby. The American species are:

POTENTILLA FRUTICOSA L. Sp. Pl. 495. 1753.

This is a native of the north temperate zone, extending in America from Labrador to Alaska south to New Jersey and Colorado. In mountain regions the leaflets are narrower with revolute margins, and this form represents *P. floribunda* Pursh, *P. fruticosa tenuifolia* Lehm. The extreme is reached by the form collected by Watson during the King's expedition and described as *P. fruticosa parvifolia* Wats. It has nearly linear leaflets and smaller long-pedicelled flowers.

POTENTILLA TRIDENTATA Soland.; Ait. Hort. Kew. 2: 216. 1789.

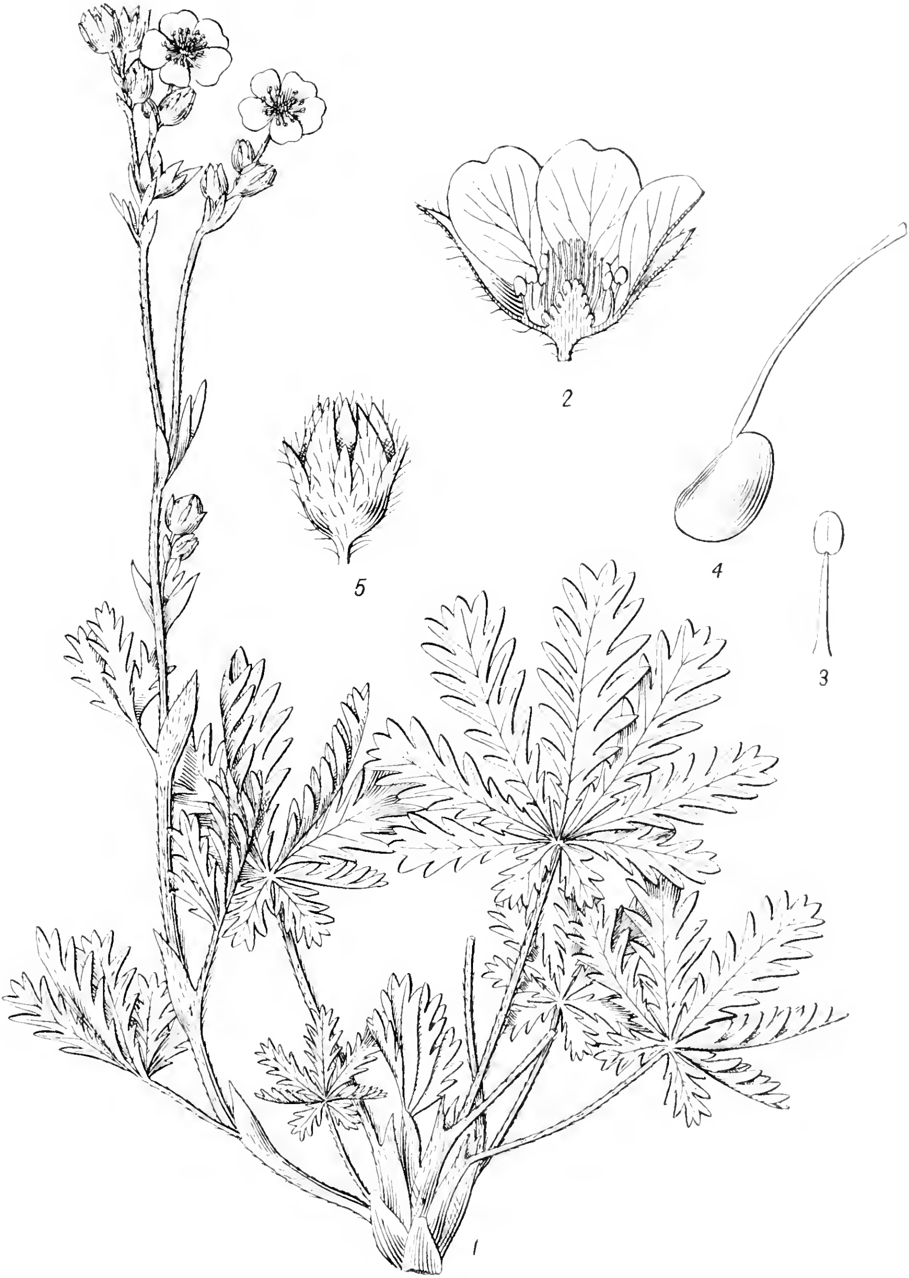
P. retusa Retz. is generally cited as a synonym of *P. tridentata* and is much older, but *P. retusa* is described as having yellow flowers, and in the figure of it in Flora Danica the petals are also yellow, while in *P. tridentata*, as is well known, they are white. If made from a specimen of *P. tridentata* it is, indeed, a very poor one, as it resembles *Sibbaldia procumbens* more than *P. tridentata*. It can, however, not represent that species, as the petals exceed the sepals. What *P. retusa* was, or is, is still a secret.

P. trudentata extends from Greenland to the mountains of North Carolina and westward to Minnesota.

Biflorae. This contains only one species, placed by Lehmann with *P. fruticosa*, *P. tridentata* and their allies. The style is, however, nearly terminal, and the achenes not hairy. It resembles the *Fruticosae* in the thickish leaves, whose margins are entire, and the non-emarginate petals. The receptacle has also very long hairs.

POTENTILLA BIFLORA Willd.; Schlecht. Mag. Gesel. Nat. Fr. Berlin, 7: 297. 1813.

It is a native of northeastern Asia, Alaska and the arctic coast of North America, but a rather rare plant.



POTENTILLA CANDIDA RYDBERG.

POTENTILLA ATRORUBENS RYDBERG.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. III.

New or Noteworthy American Grasses.—V.

BY GEO. V. NASH.

[Reprinted from THE BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 24, No. 1, January 28, 1897.]

New or Noteworthy American Grasses.—V.

By Geo. V. Nash.

Erianthus Tracyi n. sp.

Culms stout, erect, 2–4 m. high, smooth and glabrous, the nodes upwardly barbed with deciduous silky hairs, about 1 cm. long; sheaths closely embracing the culm, shorter than the internodes, smooth, glabrous, except at the apex, where they are pubescent with deciduous, long, silky, appressed hairs; ligule rounded, about 5 mm. long; leaves 5 dm. long or more, 1.5–3 cm. broad, narrowed toward the base, long-acuminate toward the apex, strongly scabrous on both surfaces, pilose on the upper side toward the base; panicle oblong, 3–5 dm. long, 8–12 cm. wide, cream-white, dense, the main axis and branches pubescent with long appressed silky hairs, the branches usually in 2's, much divided, ascending or nearly erect, 15 cm. long or less; spikelets lanceolate, 5–6 mm. long, about one-half again as long as the internodes, yellowish brown, usually marked with red, less than one-half the length of the involucral hairs; first and second scales firm-membranous, the former a little the longer, both pubescent with silky hairs, twice the length of the scales, the first acuminate, faintly 7-nerved at the base, 2-toothed and prominently 2-nerved at the apex, the two nerves scabrous, the second scale acute, the nerves hardly discernible; third and fourth scales hyaline, shorter than the first and second ones, ciliate on the margins, the third acute, 1-nerved, the fourth narrower, acuminate, 2-toothed, conspicuously 1-nerved, the nerve excurrent as a straight or slightly twisted (not spiral) awn, 1.5–2 cm. long.

Type collected at Starkville, Miss., on October 1, 1896, by Prof. S. M. Tracy, in whose honor I take pleasure in naming it. C. L. Pollard's no. 1,341, collected at the same locality, in August of the past year, is the same. Mr. Pollard informs me that it grows on moist open slopes.

The larger and denser panicle, the longer hairs both on the outer scales and at the base of the spikelet, and the longer awn, which is straight or nearly so (not coiled), readily separate it from *E. alopecuroides* L. The base of the awn in *E. Tracyi*, that portion included in the outer scales, is loosely twisted, while the same portion in *E. alopecuroides* is closely coiled.

At the present time I only have specimens from Mississippi, and would be exceedingly glad to receive more material from other localities.

PASPALUM BLODGETII Chapman.

It would seem best to maintain the above name, although perhaps not the oldest, for the plants that have been referred to *P. caespitosum* Fluegge. Chapman's type is preserved in the Herbarium of Columbia University, so that the positive identification of that species is possible. One of the forms which has been placed here is very different and surely worthy of specific rank. I have taken it out and described it below as new. Its differences from the plants here under consideration are there pointed out.

The reason which seems to make it desirable to maintain Chapman's name instead of Fluegge's is the inability to make the plants in my possession, which have been referred to *P. caespitosum*, agree with the description of Fluegge. He says, among his differentiating characters, that the scales are 5-nerved and the rachis as broad as the spikelets. In all the specimens at my disposal the scales are only 3-nerved and the rachis but one-half to two-thirds as wide as the spikelets. If this should be found to be true in all the specimens that have been referred to this species it would throw considerable doubt upon the validity of past determinations. As no certainty is possible in the matter of Fluegge's name until his type can be seen, it would seem preferable to adopt, for the present at least, Chapman's name, about which there can be no doubt, as above stated. The *P. caespitosum longifolium* of Dr. Vasey would seem to me hardly worthy of the rank of a variety, as both long and short leaves occur on the same plant.

PASPALUM SIMPSONI n. sp.

Culms, upper sheaths, and surfaces of the leaves smooth and glabrous. Culms erect, slender, 2–8 dm. tall; sheaths loosely embracing the culm, the basal ones short and appressed-villuos, the remainder longer and usually much exceeded by the internodes of the mature culms, the uppermost one elongated; ligule very short and truncate; leaves erect or ascending, lanceolate, or linear-lanceolate, 2.5–14 cm. long, 2–10 mm. wide, rounded or slightly cordate at the base, acuminate at the apex, ciliate, glaucescent above; inflorescence 8–16 cm. long, the first internode of the main axis 3.5–5 cm. in length, the remainder gradually becoming shorter; spikes usually strict, 3–5, spreading or ascending, 2.5–7.5 cm. long, pubescent and pilose at the base, the rachis flat, winged, one-half to two-thirds as broad as the spikelets, narrower and more or less flexuous toward the apex, minutely scabrous on the margins; spikelets in 4 rows, in pairs on flattened minutely scabrous shorter pedicels, obicular-obovate, 1.5 mm. long, the two outer scales membranous, 3-nerved, the first one concave, pubescent with short spreading glandular-tipped hairs, the second flat, glabrous, or sparingly pubescent at the very base, the third scale chartaceous, concave, smooth and shining, yellowish, enclosing a palet of equal length and similar texture.

Collected by J. H. Simpson on No Name Key, Florida, in May, 1891, no. 184. I take pleasure in naming this grass in honor of Mr. Simpson, whose extensive collections in southern peninsular Florida, have added much to the knowledge of the flora of that most interesting region. The *Paspalum* in question has been confounded with *P. caespitosum* Fluegge, a discussion of which species occurs above under *P. Blodgettii*, and Mr. Simpson's plant, referred to previously, was distributed under the former name. Curtiss' no. 5440, collected at the same locality on June 26, 1895, is this same plant and was also distributed as *P. caespitosum*.

This grass is readily distinguished from *P. Blodgettii*, to which it is related, by its smaller and differently shaped spikelets, the pubescence of which is short, spreading and glandular-tipped, and by the broader and manifestly ciliate leaves. The spikelets in

P. Blodgettii are elliptic or elliptic-obovate, about one-half longer, and the pubescence scantier and composed of much longer hairs, which are appressed and not glandular-tipped; the leaves, moreover, are sparingly, if at all, ciliate.

PASPALUM VILLOSISSIMUM n. sp.

Whole plant, except the culm and spikelets, densely vilous, particularly the lower sheaths. Culms erect, smooth and glabrous, 5–10 dm. tall, from a thick and more or less branching rootstock, extending, when mature, much beyond the uppermost sheath, branching at the highest node, the usually single branch exserted but little beyond the sheath; nodes purple; sheaths loosely embracing the culm, those at the base short and overlapping, the remainder elongated, the uppermost sometimes without a leaf blade; ligule truncate, less than .5 mm. long; leaves erect, linear-lanceolate to lanceolate, 3–20 cm. long, 3–10 mm. wide, truncate or slightly rounded at the base, long-acuminate toward the apex, a ring of long hairs at the very base immediately above the ligule; spike single, rarely with an additional one below, slender, usually strict, or the longer a little arcuate, 7–11 cm. long, the rachis flat, about two-thirds as wide as the spikelets, wing-margined, somewhat flexuous, the margins serrulate; spikelets orbicular-obovate, .8–.9 mm. long, .75 mm. wide, by pairs, in four rows, on hispidulous pedicels about one-half their length; first and second scales membranous, strongly pubescent with short spreading glandular-tipped hairs, the former concave and 3-nerved, the latter flat with inrolled margins, 2-nerved; third scale similar in shape to the first, greenish white, chartaceous or coriaceous, enclosing a palet of equal length and similar texture.

Type collected by the writer at Eustis, Lake County, Florida, early in June, 1894, no. 946, and distributed as *P. setaceum*, from which it seems clearly distinct, the shorter and broader leaves and the pubescent spikelets readily separating it from that species. It resembles *P. dasyphyllum* Ell. in its pubescence, but its slender long-exserted culms and the slender spikes, usually single, serve well to distinguish it. In *P. dasyphyllum* the culm is much stouter, and the thicker spikes 2–4 in number, rarely 1.

Nos. 2019, collected at the same place, and 2416a at Tampa, both in 1895, belong here.

PANICUM ALBO-MARGINATUM n. sp.

Whole plant, with the exception of the spikelets and the lowermost sheaths, smooth and glabrous. Culms erect, slender, 1.5–4.5 dm. tall, somewhat branched toward the base; sheaths short, often sparingly ciliate on the margins, those on the culm one-third the length of the internodes or less, 1.5–2.5 cm. long, those on the branches shorter and overlapping, 1 cm. long or less; ligule a ring of short hairs about .25 mm. long; leaves thick, erect, lanceolate, 1.5–4.5 cm. long, 2–8 mm. wide, acuminate, somewhat narrowed and rounded at the base, with a prominent thick, white, cartilaginous, serrulate margin about .25 mm. wide; panicle ovate in outline, the primary ones long-exserted, 2.5–4 cm. long, the branches ascending; the panicles on the branches smaller, shorter than the uppermost leaf; spikelets 1.5 mm. long, broadly obovate, obtuse, diverging from the branches; first scale orbicular, glabrous, one-fourth to one-third as long as the spikelet; second and third scales membranous, 7-nerved, strongly pubescent with short spreading hairs, the latter enclosing a hyaline palet about one half its length; fourth scale chartaceous, oval, obtuse, 1.25 cm. long, about .8 mm. wide, enclosing a palet of equal length and similar texture.

Collected by the writer in the low pine land at Eustis, Lake County, Florida, early in June, 1894, no. 925. In habit it is much like *P. sphaerocarpon* Ell. It is probably the *P. nitidum* of Elliott.

PANICUM LATIFOLIUM L.

It may be of interest to call attention to a remark of Trinius in relation to this species, although the evidence as to what plant Linnaeus had in mind is so strong that it would hardly seem worth while to allude to it further. Trinius (Mem. Acad. St. Petersb., VI., 3: Pt. 2, 262, 1834), in the latter part of his description of this species, makes the following statement in parenthesis:

"Ob quam notam et ob Sloanei iconem optimam de Linnaei planta dubium nullum."

PANICUM LEUCOTHRIX n. sp.

Culms caespitose, 1–4.5 dm. tall, erect or ascending, somewhat branched, sparingly pubescent with ascending hairs, the nodes glabrous. Sheaths less than one-half as long as the internodes, 2 cm. long or less, usually purplish, pubescent with ascending or nearly appressed long white hairs, those at the base of the sheath more dense and spreading; ligule a ring of long white, erect hairs; leaves erect or nearly so, lanceolate, 2–6 cm. long, 3–7 mm. wide, acuminate at the apex, truncate or rounded at the partly clasping base, 7–9-nerved, rough and glabrous above or with a few minute scattered hairs, pubescent below with short appressed hairs; panicle ovate or oval, 2.5–6 cm. long, 2–4 cm. broad, its branches spreading or ascending, 2.5 cm. long or less; spikelets obovate, about .65 mm. long, .4 mm. wide; first scale membranous, one-quarter to one-third as long as the spikelet, orbicular-ovate, obtuse, 1-nerved; second and third scales membranous, equal in length, 7-nerved, strongly pubescent with short spreading hairs; fourth scale chartaceous, elliptic, yellowish-white, enclosing a palet of equal length and similar texture.

Type collected by the writer in the low pine land at Eustis, Lake County, Florida, in the latter part of July, 1894, no. 1338. Nos. 334 and 467, of the same collection, also belong here.

PANICUM MANATENSE n. sp.

Whole plant, with the few exceptions described below, smooth and glabrous. Culms 2–4 dm. long, strongly striate-grooved, decumbent, much branched, the lower and longer internodes arcuate; nodes often yellowish on one side; sheaths loose, ciliate along the margins, at least when young, the lower ones much shorter than the internodes, those at and toward the extremities of the branches crowded and overlapping; ligule truncate, very short; leaves erect or nearly so; lanceolate 3.5–9 cm. long, 7–15 mm. wide, acuminate at the apex, rounded at the sparsely ciliate base, 9–13-nerved; panicle ovate in outline, 4–6 cm. long, its branches single and divided almost to the base, 1.5–3 cm. long, ascending; spikelets on ascending pedicels usually longer than themselves, elliptic about 3.5 mm. long, 1.3 mm. wide, very acute; first scale membranous, slightly exceeding one-third the length of the spikelet, ovate, acute, 1–3-nerved; second and third scales 7–9-nerved, membranous, acute, strongly pubescent with spreading hairs, the latter with a hyaline palet about one-third its length; fourth scale chartaceous, elliptic 2.5 mm. long, strongly apiculate, enclosing a palet of similar texture as long as itself.

Collected by the writer on August 21, 1895, near a sulphur well in a wet hammock northeast of Palmetto, Manatee County, Florida, no. 2428a. Approaching *P. commutatum* Schult. in habit and general appearance, but the large and very acute spikelets readily distinguish it from that species.

AGROSTIS IDAHOENSIS n. sp.

Culms caespitose, slender, 2–4 dm. tall, erect, bearing usually two distant leaves below the middle; sheaths loosely embracing the culm, the lower ones short, the uppermost one elongated 4.5–9 cm. long; ligule membranous 3-4 mm. long, obtuse, cut-toothed at the apex, minutely pubescent on the outside; leaves narrowly linear, erect, 4–9 cm. long, 1–2 mm. wide, acuminate at the apex, rough, particularly on the margins; panicle oblong, 6–12 cm. long, 2.5–4.5 cm. wide, the axis smooth below, slightly scabrous above as are the branches and pedicels; branches of the panicle ascending 5.5 cm. long or less, usually in 5's, the secondary branches more or less spreading; spikelets lanceolate and acuminate when closed, 2 mm. long, generally about equaling the pedicels, which are decidedly thickened at the apex and usually more or less spreading; empty scales acuminate, purplish, scabrous on the keels, the first longer than the second; flowering scale about three-fifths as long as the first scale; palet wanting.

Collected by A. A. and E. Gertrude Heller, at Forest, Nez Perces County, Idaho, on July 16, 1896, at an altitude of 3,500 feet, no. 3431. A very delicate and beautiful member of the genus and perfectly distinct from any species of that region with which I am acquainted.

DANTHONIA GLABRA n. sp.

Whole plant, with the few exceptions noted below, glabrous. Culms 4–7 dm. tall, erect, simple, striate, slightly rough just below the panicle, and puberulent for some distance below the brown nodes; sheaths smooth, only those at the base of the culm exceeding the internodes, the remainder much shorter than their internodes; ligule densely ciliate with silky hairs 1–2 mm. long; leaves smooth excepting at the apex, 1.5–3 mm. wide, erect, those on the sterile shoots 1.5 dm. long or more, those on the culm 5–10 cm. long, the basal ones shorter than the rest; panicle 5–8 cm. long, its axis, together with the erect or occasionally spreading branches, hispidulous; spikelets, including awns, 1.7–2 cm. long, 5–8-flowered, on hispidulous appressed pedicels, 2.5–7 mm. long; empty scales acuminate, the first 3-nerved, 1.3–1.7 cm. long, equalling or slightly shorter than the 5-nerved second; flowering scales 5–6 mm. long to base of the teeth, pubescent on the lower half of the margins, and occasionally sparingly so on the mid-nerve near the base, with erect silky hairs about 2 mm. long, teeth including awns 1.5–3 mm. long, one of the awns usually shorter than the other, the central awn 9–12 mm. long, more or less spreading, yellowish brown at the base, strongly hispidulous toward the green apex, about once twisted; palet about reaching to the base of the awn or nearly so, strongly ciliate on the two nerves.

Type specimens collected by Dr. John K. Small, on Little Stone Mountain, DeKalb County, Georgia, on July 5, 1895. In this the flowering scales are entirely glabrous on the back. In another form from New Jersey the flowering scales are sparingly pilose on the back near the base. This latter form was secured by Dr. John Torrey, at Quaker Bridge, in May, 1830; also by a party of the Torrey Botanical Club at Forked river, on May 30, 1896.

This is abundantly distinct from *D. sericea* Nutt., to which it is allied. In that species the sheaths are densely villous, and the marginal hairs of the appressed-pubescent flowering scales are about 3 mm. long, instead of 2 mm. as in *D. glabra*.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 112.

An Apparently Undescribed Species of Prunus from Connecticut.

(Plate 292.)

A New Polygonum from Bolivia.

(Plate 293.)

The Relation Between the Genera Thysanella and Polygenella as Shown by a Hitherto Unobserved Character.

BY JOHN K. SMALL.

[Reprinted from The Bulletin of the Torrey Botanical Club, Vol. 24, No. 1, January 28, 1897.]

An apparently undescribed Species of Prunus from Connecticut.

By John K. Small.

(Plate 292.)

To venture to describe a new species of *Prunus* from the long explored territory of the State of Connecticut may seem to some to be questionable, but so clear a case has recently come to my notice that to do otherwise would be unjust to nature.

The plant in question is a low slender branching shrub, reaching a maximum height of about twelve decimeters. The main stem is clothed with a dark rough bark and, like the principal branches, is leafless, the ascending twigs and branchlets only producing leaves. The small white flowers are confined to the branchlets just below the leaf-producing parts. The small globose drupe is deep purple or almost black, covered with an abundant light blue bloom. To the taste the fruit is bitter and astringent.

The species occurs on a cross-shaped area, on a low gravelly ridge near Long Island Sound, at Groton, Connecticut, and is related to *Prunus maritima*, which grows in the immediate neighborhood and under precisely the same conditions, thus affording an excellent opportunity for a comparison of characters:

1. The new species is lower, more slender and delicate in habit than *Prunus maritima*, maturing both its leaves and fruit earlier in the season.

2. The small suborbicular type of leaf, as against the larger elongated type characteristic of the beach plum. This character is very apparent from the time the buds begin to unfold.

3. The smaller flowers with the suborbicular petals, which are about 5 mm. in diameter and abruptly narrowed at the base, as compared with the larger broadly obovate petals of *Prunus maritima*, which are gradually narrowed at the base.

4. The smaller always globose short-pedicelled drupe, in place of the longer often elongated and long-pedicelled fruit of the beach plum.

5. A small and very turgid stone (nearly as thick as broad), which is pointed only at the base. The stone of *Prunus maritima* is flatter and usually pointed at both ends.

6. Sprouts arising from the ground never produce flowers, as they frequently do in the case of *Prunus maritima*.

This plum was discovered by Dr. Charles B. Graves, of New London, Connecticut, to whom I am indebted for specimens and much of the substance of this paper, and whose name I wish to associate with the plant as

PRUNUS GRAVESII n. sp.

A low, unarmed shrub; stems erect or ascending, reaching a maximum height of 12 dm., much branched, clothed with a dark rough bark, leafless like the ascending branches; twigs and branchlets less leafy, usually puberulent; leaves orbicular or oval-orbicular, varying towards orbicular-obovate, 2–4 cm. long, rounded or retuse and apiculate at the apex, sharply serrate or those of the shoots crenate-serrate, abruptly narrowed, rounded or truncate at the base, sparingly pubescent or glabrate above, more pubescent beneath, especially on the nerves; flowers pure white, 1–3 cm. broad, solitary or 2–3 together, scattered on the twigs near the top of the shrub; pedicels stiff, stout, 6–10 mm. long, pubescent; calyx pubescent like the pedicels, the tube campanulate, the segments oblong, as long as the tube; petals sub-orbicular, about 5 mm. in diameter, abruptly narrowed at the base; drupe globose, solitary, 10–15 mm. in diameter, usually 12.5–13 mm. in diameter, deep purple or almost black with an abundant light blue bloom, bitter and slightly astringent; stone broadly oval, broadly crested, 7.5–9 mm. long, 7–8 mm. broad and 6–6.5 mm. thick, very turgid on one side, acute at the base, rounded at the apex.

In the year 1895 the species flowered during the last week of May and matured its fruit the first week of September.

A new Polygonum from Bolivia.

By John K. Small.

(Plate 293.)

Polygonum fallax n. sp.

Annual or perennial by a long somewhat spiral root, low, dull green. Stem more or less densely and caespitosely branched near the top of the root, the branches spreading or prostrate and ascending, 2–12 cm. long, very leafy except at the base; leaves varying from ovate-oblong to obovate-oblong, 3–5 mm. long, obtuse, somewhat revolute and crisped, narrowed at the base, wrinkled above, slightly nerved beneath, the mid-nerve keeled beneath, especially near the base, obliquely articulated at the base of the ocreae; ocreae funnelform, 4 mm. long, imbricated, especially toward the ends of the branches, at length lacerate to a little below the middle; flowers numerous and often crowded; calyx 2.5 mm. long, 5-parted, 4 segments green, with whitish margins, 1 wholly included and hyaline, all rounded at the apex, stamens usually 5 or 6; filaments dilated their whole length into a broadly ovate hyaline petal-like organ; style two-parted, .4 mm. long; achene lenticular, ovoid, 2.5 mm. long, reddish, nearly smooth, shining, its faces convex, its angles rounded, sometimes faintly margined.

A species of especial interest collected in Bolivia by Mr. Bang and communicated to me by Dr. Rusby. Although it belongs to the subgenus *Avicularia*, its fruit possesses characters heretofore unknown in that subgenus. The several natural groups of *Polygonum* bear two kinds of achenes, some lenticular, others triquetrous, while in a few cases both forms appear. *Avicularia* has been known to produce only the triquetrous achenes developed from a three-angled ovary with a more or less three-branched style, but in *Polygonum fallax* we are confronted with a species of subgenus *Avicularia* bearing only lenticular achenes developed from lenticular ovaries with two-branched styles.

A second peculiarity is exhibited in the pericarp which most closely resembles that of the different members of the subgenus *Duravia*, both in texture and color, but the styles are not those of that group. Another interesting point is found in the androecium; the filaments are dilated into broad petal-like organs, which form a cup around the ovary. I know no other case like this in the genus. Notwithstanding these exceptions, the species for the present must be referred to *Avicularia* and forms the first exception to its normal morphology as far as I have observed, and an interesting one.

Explanation of Plate 293.

1. Whole plant, natural size.
2. Leaf, enlarged.
3. Flower, enlarged.
4. A stamen, enlarged.
5. Achene, enlarged.
6. Cross-section of achene, enlarged.

The Relation between the Genera Thysanella and Polygenella as shown by a hitherto unobserved Character.

By John K. Small.

The genus *Thysanella* has generally, and apparently without good reason, been included in *Polygonum*.

In a former paper* I stated that *Thysanella* was a perfectly distinct genus, related to *Polygonella* and not to *Polygonum*.

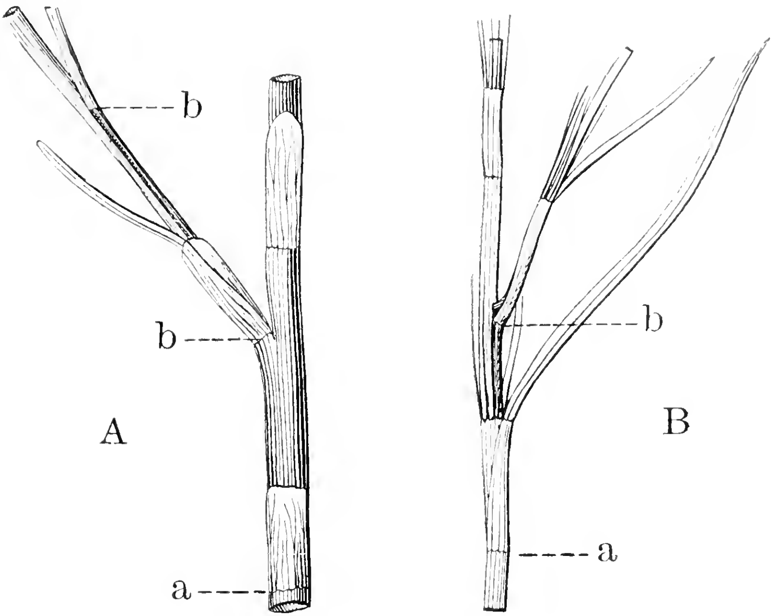
A glance at *Thysanella fimbriata* and any member of the genus *Polygonella* ought to be sufficient to convince any one of the strong relationship between the two genera. The habits of the two are almost identical, while the vegetative organs of *Thysanella* much more closely resemble those of *Polygonella* than they do any member of *Polygonum*.

Coming to special morphological characters let us first consider the flower. Here we find the special development in the inner series of sepals; likewise in *Polygonella* it is the inner sepals that develop special organs. In *Polygonum* the outer sepals are specialized if any development at all takes place, the inner series being practically unmodified.

Besides the foregoing considerations I have lately noticed a character in both the genera *Thysanella* and *Polygonella* which is possessed by no other member of the family *Polygonaceae*. In the

* Mem. Dept. Bot. Col. Coll. 1: 9.

one species of *Thysanella* and in all the species of *Polygonella* the branching is not nodal, but internodal.



The internodal branching is brought about by the adnation of a secondary axis to a primary axis for a greater or less distance above a secondary node, usually about one-half the distance from node to node. The true condition is more plainly shown in *Thysanella*, where the union of the two axes is not as complete as in *Polygonella*, a shallow but usually distinct groove showing the place of union.

Explanation of the Figure.

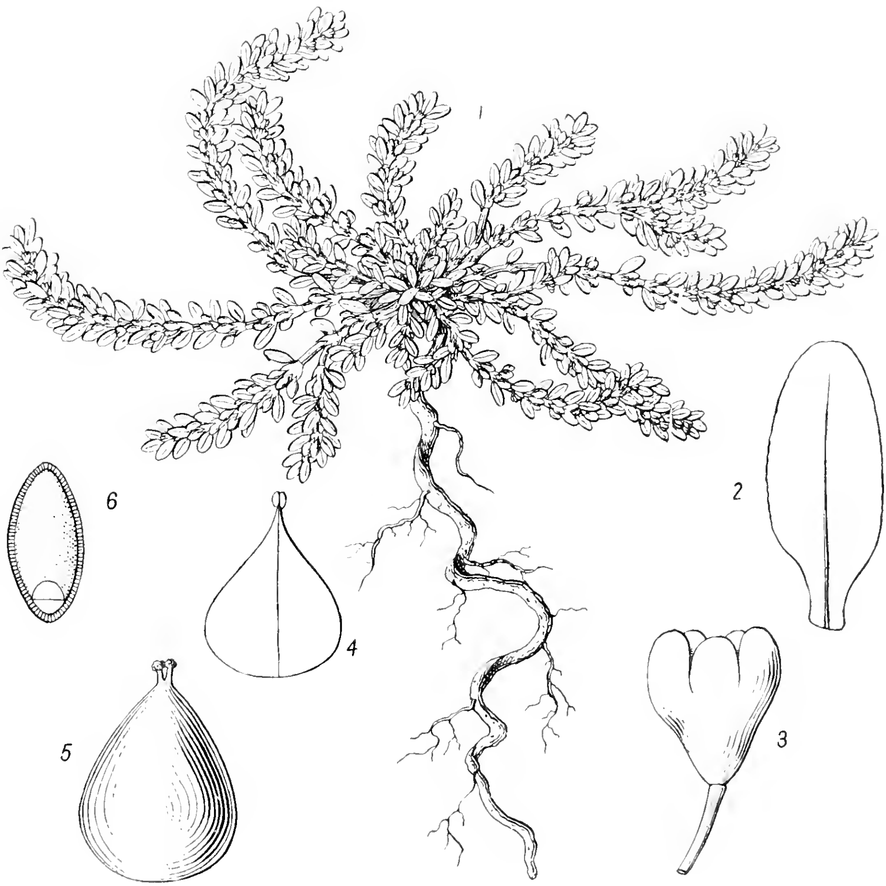
A. *Polygonella Americana* (F. & M.) Small.

B. *Thysanella fimbriata* (Ell.) A. Gray.

a. Nodes.

b. Point where the adnate axis diverges.

PRUNUS GRAVESII SMALL.



POLYGONUM FALLAX SMALL.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 113.

Some New Fungi, chiefly from Alabama.

By Lucien Marcus Underwood.

[Reprinted from The Bulletin of the Torrey Botanical Club, Vol. 24, No 2, Feb. 1897.]

Some new Fungi, chiefly from Alabama.

By Lucien Marcus Underwood.

In certain favorable seasons the Southern States offer fine opportunities for field work in mycology. It is fortunate that we are beginning to have intelligent field workers that are resident instead of transient collectors, for it is only by persistent resident work that anything like a clear understanding of the flora can be obtained. While much is still to be desired in many of the Southern States, it can safely be said that the States of Alabama and Mississippi, at least, are now fairly well equipped with local workers, as compared with neighboring States, if one or two workers for an area of 50,000 square miles can be regarded as a fair equipment. Many species are comparatively ephemeral, and only the local observer who is at hand at the favorable moment is able to gather the harvest. The fall season of 1895 was specially unfavorable for field work, on account of excessive drought, and this condition prevailed more or less throughout the spring season. In fact, not until July, 1896, were the rains sufficient to bring out the normal hymenomycetous flora. Since that time, and particularly during the months of October, November and December, 1896, Professor Earle reports a very prolific growth of fleshy species, and among them he sent a very interesting series of the central and lateral stemmed forms of the genera *Polyporus*. These, together with a few others collected by myself in the same region, and one or two from elsewhere, are described below. For convenience the genera and species are arranged alphabetically.

HYDNUM CHRYSOCOMUM n. sp.

Resupinate, forming areas 2–6 cm. each way; mycelial strands wide-creeping, more or less branched, bright orange-yellow, expanding here and there to form a membranous subiculum bearing the bright orange-yellow spines; subiculum thin, whitish fimbriate at the margin, yellowish within and later bright orange-yellow; spines crowded, 1 mm. or more long, often confluent so as to appear flattened, terete when single, concolorous, rather obtuse.

Growing under much decayed sticks, New Dorp, Staten Island, New York, October 17, 1896. Smaller and imperfect specimens had been previously found in Indiana and Alabama, with well-developed mycelium and scanty spines. A well-marked species and easily recognized by its brilliant mycelial strands and the color of its spines.

LEPIOTA MAMMAEFORMIS n. sp.

Pileus thin, white, with a dull brownish strongly umbonate disc, 5-8 cm. in diameter, mealy squamulose, the margin strongly sulcate-striate, somewhat incurved; gills rather narrow, moderately close; stem 12-18 cm. long, flexuous, hollow, tapering upward from an elongate thickened base, over 1 cm. at its greatest thickness, the narrow distant annulus often finally deciduous.

Growing caespitosely from near the base of a decaying *Broussinetia* on the streets of Auburn, Alabama, July 1896. The gills turn darker in drying and the umbo becomes strikingly prominent.

LEPTOGLOSSUM ALABAMENSE n. sp.

Black throughout, gregarious, 2–3 cm. high. Ascoma about 1 cm. long, flattened, in the dry condition about 2 mm. wide and 0.5 mm. thick, blunt or rounded, horny, yellowish within; stem roughened, somewhat enlarged at base; spores hyaline, straight or slightly more or less curved, biseriate in the asci, becoming 4-septate, $18–20 \times 4 \mu$; paraphyses abundant, thickened and darker colored at the tip.

On the ground, Auburn, Alabama. July.

Peronospora Plantaginis n. sp.

Mycelium parasitic in well-defined yellow areas of the leaf, occupying the entire width and a length of 1–3 cm.; conidiophores usually solitary, long exserted, irregularly 5–6 times dichotomous; ultimate ramulae short, unequal, recurved, 4–12 μ long; conidia narrowly oval or lemon-shaped, pointed at each end, dark, almost black by reflected light, brownish violet by transmitted light, 40–44 x 16–18 μ. Oöspore unknown.

On leaves of *Plantago aristata*, Auburn, Alabama, May, 1896. F. S. Earle.

Peronospora Seymourii Burrill n. sp.

Sparse, forming white patches or lines on leaves and stems; oöspores on floral organs. Mycelium large, distorted, haustoria knob-like; conidiophores slender, seven or eight times dichotomous, branches flexuous, spreading, tips short or of moderate length, subulate; conidia subglobose to elliptical, variable, 12–18 μ by 14–27 μ, brownish; oögonia with firm, rather thick brownish walls, reaching 70 μ in diameter; oöspores dark brown, opaque, thick-walled, rough, 27–45 μ.

On *Houstonia* sp. Union and Jackson counties, Illinois, April 11–28, 1882. (A. B. Seymour.)

The above description was furnished me by Professor T. J. Burrill. Having found what appeared to be an undescribed species of *Peronospora* on *Houstonia patens*, in Auburn, Alabama, I learned by accident that a species had been found on the same host many years ago and that its description written at the time by Mr. Seymour had laid in manuscript until now. The Alabama specimens appear to be the same species, but no oöspores were found. In the Alabama specimens the conidiophores were about 400 μ long, with a diameter of about 6 μ; the branching was alternate, the main branches being 70–90 μ long and the ultimate branches or sterigmata 6–10 μ; the conidia were more often ovate, 21 by 11–14 μ.

Polyporus decurrens n. sp.

Mesopous; terrestrial; pileus nearly circular, 5 cm. in diameter, plane or slightly depressed at the centre, brown or bay-colored, covered with a thin crust which is glabrous except where it is raised at certain points to simulate, when dried, an imbricated surface; pores nearly white, forming a layer about 2 mm. deep, decurrent on the stem and vanishing in faint reticulations just above the base, slightly angular, 0.5 mm. in diameter; dissepiments thin, entire; context white, probably fleshy when fresh, compact, homogeneous, about 7 mm. thick at the centre, gradually becoming thinner; margins thin, slightly involute when dry; stem somewhat bulbous at base, 3 cm. or more long, tapering above, 1 cm. in diameter at the apex, 1.5 cm. below, somewhat darker than the pores.

Growing in soil on the side of a cañon near the Soldier's Home, near Los Angeles, California. Feburary, 1896. Dr. H. E. Hasse. (Communicated by A. J. McClatchie.)

A very characteristic species; the pileus in drying presents a very irregular surface, certain points which have the appearance of slight imbrications remaining more elevated, while the intermediate spaces become deeply depressed; it is hoped that more material can be secured of this interesting plant and that its characters may be noted in the field. The measurements were made from the dry specimen and are naturally somewhat less than in the fresh condition.

Polyporus Earlei n. sp.

Mesopous; terrestrial; stem 4–5 cm. long, 1–1.5 cm. or more thick, colored like the pileus; pileus 7–12 cm. each way, cinereous, slightly darker towards the centre; margin very thin, much incurved in drying; context soft-fleshy, grayish, drying to a thin layer; pores 1–2 mm. deep, somewhat whitish-stuffed when young, cinereous gray, paler when young and, towards the margin, small (less than 0.5 mm.), the dissepiments rather firm, entire.

Pine woods, Auburn, Alabama, Nov., 1896. Prof. F. S. Earle.

The plant is cinereous throughout and retains this color when dry. It gives me great pleasure to associate with this plant, the name of my former genial co-laborer and companion in many "fungus forays," who is contributing largely to our knowledge of mycology in a much neglected section of the Union.

Polyporus flavo-squamosus n. sp.

Pleuropous; terrestrial; stem 7–8 cm. long, 4–5 cm. thick, slightly flattened, irregularly roughened, colored like the pileus; pileus 15 cm. each way, yellowish, with a slight tinge of greenish; covered with rather small floccose imbricate scales, which form a very thin fragile crust, channeled behind where the edges nearly meet; margin rather acute, more or less incurved in drying; context white or slightly yellowish, fleshy, firm, becoming almost woody when dry; pores 5 mm. deep, rather large (about 1 mm.), irregular, angular, with thin dissepiments, slightly decurrent, white, changing to greenish where wounded, yellowish when dry; spores oval or ovoid, 9 x 6 μ, with a single large highly refractive gutta.

Growing in clayey soil, Auburn, Alabama, 23 Nov., 1896. Mrs. F. S. Earle.

POLYPORUS IRREGULARIS n. sp.

Pileus irregular, more or less branching, brownish, paler towards the margin, uneven, subtomentose, with a thin imperfect crust, the under layer of which is darker colored, forming a delicate brown line in section; 4–6 cm. long, 3–4 cm. wide, the margin usually thin; context white, floccose-felty pores white, 5 mm. or more deep, irregular, more or less angular, small (0.25 mm.), the dissepiments rather thin, firm, even.

Growing irregularly underneath a pine log, Auburn, Alabama, Feb., 1896.

The older portions are ferruginous brown above, and the free margins, when developed, are thin and distinctly paler brown for a space of about 1 cm. The extreme margin is sterile, and the pores which are normally even, become irregular and oblique as the margin tends to become erect.

POLYPORUS MELIAE n. sp.

Pileus convex, dirty white, subtomentose, anoderm, 5–8 cm. in diameter, occasionally coalescing; margin obtuse, sometimes extending nearly or quite around the pores; cortex floccose-corky, whitish; pores cream white, becoming darker with age, more or less rimose, 5–6 mm. deep, minute (about 0.2 mm.), the dissepiments firm, slightly uneven, usually with obtuse edges; spores narrowly oblong, 6x3, hyaline.

On branches of *Melia Azederach*, Auburn, Alabama, Oct., 1895.

In very old specimens the layer of pores becomes cracked in all directions and very much discolored.

POLYPORUS RETIPES n. sp.

Terrestrial; stem excentric, 4–6 cm. long, 2 cm or more thick, yellowish-white towards the base; pileus 6–15 cm. each way, brown, appressed tomentose, finely areolate-rimose so as to appear finely mottled; context fleshy, rather thick (2 cm. or more) becoming quite thin in drying, whitish; margin acute; pores decurrent half the length of the stem, shallow, whitish, large (1.5 mm. or more), mostly hexagonal, the dissepiments thin and finely lacerate.

The young pores are very shallow and the stem appears reticulate-veined nearly to the base. As the pores become older they deepen and those nearest the base of the stem become more or less obscured.

In pine woods, Auburn, Alabama, Dec., 1896. Mrs. F. S. Earle.

PUCCINIA POLYSORA n. sp.

II., III. Amphigenous; sori very small, short, very numerous but irregularly scattered, remaining long enclosed in the tough epidermis of the host, at length rupturing by a narrow slit; uredospores large, broadly oval, 35 × 30 μ, scarcely echinulate, the epispore of medium thickness, pale rusty brown; teleutospores variable, usually short, irregularly oblong, often somewhat constricted at the septum, averaging 25 × 40 μ, the cells often irregularly angled, the upper usually broader than long, blunt or rounded above; apex not thickened; pedicel usually short.

On *Tripsacum dactyloides*, Auburn, Alabama, August and October, 1891, B. M. Duggar.

USTILAGO SPARSA n. sp.

Parasite infesting occasional ovaries and transforming them into somewhat sphaerical olivaceous pustules covered by the changed and roughened seed coat, 1–3 mm. in diameter, the remainder of the inflorescence unchanged; spores regularly oval, distinctly echinulate, about 7–9 μ in length.

Related to *U. neglecta* Niessl. and *U. spermophora* B. & C., but distinguished from them by its larger pustules and smaller spores. It has nothing in common with *U. Dactyloctaenii* P. Henn. Die Pflanzenwelt Ost-Afrika, 5 : 48 which occurs on the same host, has dark violet horn-shaped sori and smooth spores, 10–14 μ.

In scattered ovaries of *Dactyloctenium Aegyptium*, Auburn, Alabama, November, 1895, and October, 1896. Underwood & Earle.

February 8, 1897.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 114.

An undescribed Lechea from Maine.

By Eugene P. Bicknell.

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An undescribed Lechea from Maine.

BY EUGENE P. BICKNELL.

One of the most characteristic plants of York Harbor, Maine, is a species of *Lechea* which abounds in dry open places, especially over the weedy downs near the sea. Upon visiting York Harbor some years ago my attention was at once arrested by this plant, which was obviously neither *Lechea intermedia* nor *Lechea maritima*, the only eastern pinweeds which could be considered at all in connection with it. Subsequent investigation discovered that the plant, though it had never been discussed in print, had not been overlooked by botanists, but had been a long-standing puzzle variously solved, it appeared, in terms of one or the other of the species named above. Material from different collectors which had formed part of Mr. Leggett's collection and bore his penciled memoranda showed that the plant had perplexed that careful student of the genus, who had at different times referred it doubtfully both to *Lechea intermedia* and to *Lechea maritima* and had at least entertained the idea that it might be referable to the more western *Lechea stricta*. It may be said here that Mr. Leggett's material was not fairly representative of the plant and was quite insufficient to form a basis for any safe conclusions. For this reason the same material was passed over by Dr. Britton in his revision of the genus (Bull. Torr. Club, **21**: 244–253, 1894), which therefore affords no help in the present case. In Dr. Robinson's recent critical treatment of the genus (Syn. Fl. **1**: Part 1, 192–194, 1895) we find the first published notice of the Maine plant. It is there mentioned under *Lechea stricta* as being nearly related to that species, but as probably to be referred to *Lechea intermedia*. The case, therefore, stands to-day just as it was left by Mr. Leggett over fifteen years ago.

During several visits to York Harbor in August this pinweed has claimed my particular attention, and I have realized in the field that the problem it presented was indeed a perplexing one.

The main facts in the case seem to be these: The plant has much the aspect of *Lechea stricta*, and is hence frankly distinguished in appearance from *Lechea intermedia;* nevertheless, though closely allied to the former it is not that species, but is a more or less immediate derivative of the latter, as is shown by the occurrence of forms not satisfactorily referable to either plant.

Technically, therefore, on the evidence, the plant is a variety of *intermedia*—an incompletely detached derivative of that species. Actually it has reached a degree of differentiation which, measured by the slight differences separating species in this group of plants, is certainly remarkable, and may fairly be taken as of species value despite the apparently intergrading forms. Indeed, so distinct from *intermedia* does the typical plant appear that it may well be questioned whether intergradation between the two is not, after all, more apparent than real. When we recall instances of perfectly distinct species exhibiting an apparent identity up to the time of full maturity of flower or fruit we find ourselves less ready to assign doubtful specimens to the category of intergrades. It may be readily conceived that between certain individuals of nearly related plants an inherent distinctness may be completely disguised to the eye as a result of retarded development or other cause. Be this as it may, I am sufficiently satisfied of the expediency of recognizing as a species the *Lechea* here discussed. To refer it to either of its near allies would be to evade a difficulty through a makeshift, and as for varietal rank the grade *variety* has been misused out of all definite meaning. Species are necessarily of different values. Closely similar but trenchantly distinct plants range side by side with species far more divergent from each other, yet inter-related through medial forms. The relegation of such well-characterized plants to the vague rank of *variety* surely involves a disregard of the facts of nature not to be excused by an appeal to the supposed requirements of a system of nomenclature necessarily more or less artificial.

For the new plant I propose the name *Lechea juniperina* in allusion to the appearance of its densly leafy narrow panicle, which is often suggestive of a spiry red cedar (*Juniperus Virginiana*) in miniature.

LECHEA JUNIPERINA n. sp.

Tufted from a descending and branched woody root, 2–5 dm. high. Stems erect, often from an outcurved or ascending base, mostly purplish and naked below the middle at flowering-time, branched above the middle to form a dense narrow panicle; branches short, numerous, closely ascending, mostly 2–5 cm. long (1–9 cm.); pubescence consisting of fine white hairs, at first densely appressed, becoming loosely substrigose-hoary or even subtomentose-canescent; leaves numerous, crowded, ascending or appressed, thickish, slightly revolute in drying, only the mid-vein evident, glabrous above, below with the midrib finely strigose-pubescent, and with some loose marginal hairs, the petioles 1–2.5 mm. long, appressed white-pubescent on the under side; stem-leaves linear to oblong-linear and oblanceolate, mostly tapering towards the base and more abruptly narrowed at the apex, acute or subacute, 1–2.2 cm. long, 2–4 mm. wide, those of the branches much smaller, narrowly linear, acute; inflorescence forming a dense and leafy narrow panicle, 10–20 cm. long (in reduced plants much smaller and more or less terminal), the numerous short-pedicelled flowers crowded in short axillary racemes and clustered at the ends of the branches; fruiting calyx ovoid-ellipsoid, 1.5–2 mm. long; pedicels 1–3 mm. long, often very short in the clustered terminal flowers; inner sepals elliptic, subacute, nerveless or faintly 3-nerved, reddish-purple, at least on the margins, the shorter outer sepals usually bright green in marked contrast; capsule ovoid-subglobose, 1.5–2 mm. long; petals reddish-purple, oblong-linear, with only a mid-vein, about 2 mm. long by 1 mm. wide; leaves of basal shoots narrowly elliptic, acute at each end, somewhat pilose-hairy on the midrib and margins or nearly glabrate. The plant blooms in August. The basal shoots do not begin to develop until September.

In reduced states the plant is only 1–3 dm. high and linear in general outline, the more persistent leaves appressed, the shortened panicle more or less terminal and sometimes only 1 cm. wide.

A form which grows in the shade of copses or park-like woods is more slender and less leafy than the typical plant of neighboring open ground, the leaves looser and often spreading, the more open panicle much less floriferous and more racemose-paniculate.

Specimens have been examined from various localities along and near the Maine coast from York Harbor to Mt. Desert.

Lechea intermedia Leggett differs from *L. juniperina* in less tufted habit and often larger size, becoming 7 dm. tall. The pubescence is somewhat coarser and more strigose, and composed of shorter, less whitened hairs, never becoming tomentose or canescent. The stem is usually greener, with the more persistent leaves less crowded and appressed and with more verticillate tendency. The leaves are often larger and longer, becoming 2.8 cm. long and 5 mm. wide, and are rarely if ever distinctly oblanceolate. The panicle is more or less loose and open with fewer and larger, more globose, longer-pedicelled flowers, which are mostly loosely racemose and never glomerate-clustered. The broader usually orbicular sepals are green or only with the slightest purplish tinge and strongly nerved, the nerves often five in number and branched; the petals are larger and broader and mostly 3-nerved, the stigmas twice as large, the outer sepals commonly shorter and closer. The leaves of the basal shoots are often larger and relatively narrower and usually more hairy.

Lechea stricta Leggett, as compared with *L. juniperina*, is a paler, more silky-canescent plant, especially when young, the narrower acute leaves more pubescent, even pubescent over the lower surface and sparsely hairy above, the branches longer and massed above to form a broader panicle, the rather smaller and more globose longer-pedicelled flowers not at all glomerate, but distinctly racemose-paniculate and showing little or no purple.

L. juniperina appears to occupy a somewhat intermediate position between *L. intermedia* and *L. maritima* Leggett, although it need never be confused with the latter. *L. maritima* is, in fact, very distinct from all our species and is strongly characterized by its rigidly bushy-branched habit, dense tomentose-canescence and the oblong densely-pubescent leaves of the basal shoots.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 115.

Chromatin-reduction and Tetrad-formation in Pteridophytes.

(Plates 295, 296.)

By Gary N. Calkins.

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Chromatin-reduction and Tetrad-formation in Pteridophytes.

By Gary N. Calkins.

(Plates 295, 296.)

From the time when Van Beneden, in 1883, found that mature reproductive cells have only half as many chromosomes as the ordinary somatic cells, until the present time, cytologists have endeavored to explain the meaning of this reduction and to show how it takes place. These efforts have not as yet been attended with complete success.

One of the most widely known theories as to the meaning of reduction is that of Weismann who accepted the earlier conception of Roux (1883) as to the significance of mitosis and built upon it an elaborate theory of development. In this he predicted that a form of mitosis would be found in the maturation of the reproductive elements "in which the primary equatorial loops are not split longitudinally" (p. 371) and "by means of which each daughter nucleus receives only half the number of ancestral germ-plasms possessed by the mother nucleus" (p. 375).

Weismann's prediction has been confirmed by recent observations on the copepod crustacea, and it is now known that in this group of animals at least, the chromosomes of a maturing cell undergo a transverse division, giving reduction in the Weismann sense. This process of reduction, wherever definitely made out, is invariably preceded by an arrangement of the chromatin into four-parted chromosomes, to which the name "*Vierergruppen*" or "tetrads" has been given. These tetrads are always half as numerous as the chromosomes of the somatic cells and often differ widely from them both in shape and size.

The entire question of reduction rests upon the manner of tetrad-formation, but unfortunately, observers are diametrically opposed in their descriptions of the process. On the one hand it has been shown beyond question, that in some cases (the copepod crustacea) two of the four parts of the tetrad are formed by longitudinal division of the spireme-segment, while the other two arise by transverse division. In such cases two successive mitoses divide the tetrads, first into two dyads and second into single elements. By these two divisions the resultant reproductive cell receives one-fourth of each of the original tetrads. On the other hand, in another case, *Ascaris megalocephala*, where the facts also seem to be beyond contradiction, Brauer has shown that the tetrads arise by double longitudinal division of the spireme-segments and that no transverse division takes place. In this case reduction is purely quantitative and not qualitative.

The botanists Guignard (1891) and Strasburger (1888) have maintained that in plants also, a reduction in the Weismann sense does not take place. Neither Guignard nor Strasburger found tetrads. They described the spireme as breaking up into half the normal number of chromosomes which undergo simple longitudinal division at each successive mitosis.

It would be remarkable if a process so general in animal cells as the formation of tetrads should not be found in plant cells, and with the hope of finding some evidence of this in plants I undertook the study of reduction in the group of Pteridophytes, the results of which are given in the following section.

I. Observations.

Guignard and Strasburger found that in *Lilium* and in *Allium* the pollen-grain after reduction, undergoes subsequent mitoses, in each of which the same reduced number of chromosomes is retained. This led Overton (1892) to suggest that reduction in the higher cryptogams, where sexual and asexual generations alternate, might take place as far back as the formation of the spore. He also suggested that all of the cells of the sexual generation might have the reduced number of chromosomes, and in 1893 he strengthened his position by showing that the cells of the endosperm in the Gymnosperm *Ceratozamia*, divide with the reduced number. But it was Strasburger (1894) who proved it, beyond doubt, by showing that in the fern *Osmunda* all the cells of the prothallus have the reduced number of chromosomes; in other words that all cells derived from the spore have half as many chromosomes as the cells of the asexual generation. Reduction in ferns, therefore, takes place during the formation of the spore and here, if anywhere, we must look for the tetrads.

A. Material and Fixation.—Two fern species (*Pteris tremula* and *Adiantum cuneatum*) were selected, which were found in a fernery in October, to be in various stages of spore-formation. The pinnae were removed and cut into small pieces before fixation. The fixing agents used were 1, Herman's platino-aceto-osmic mixture; 2, Von Rath's fluid; 3, corrosive sublimate; 4, sublimate-acetic; and 5, picro-acetic. The best results were obtained with 1, 3 and 4. The pieces were imbedded in paraffine and cut horizontally in sections about 4 to 5 μ thick. The stains used were Heidenhain's haematoxylin, either alone or with orange G or Congo red as counter stains in the majority of preparations, although Flemming's triple stain gave good results.

B. Terminology.—In animals three periods are recognized in the development of the reproductive cells (O. Hertwig). 1. A "division period," during which the primordial germ cells ("oögonia" and "spermatogonia") increase by ordinary mitoses; 2, a "growth-period," during which the primordial germ cells enlarge and during which tetrads are formed. These cells are known as "primary oöcytes" and "primary spermatocytes," and 3, the "maturation-period," during which the nuclei with tetrads are divided by mitosis into nuclei with dyads ("secondary oöcytes" and "secondary spermatocytes"). These are again divided to form eggs or spermatids.

As regards the periods of maturation it can now be shown that both male and female cells in many animals, and reproductive cells in some plants (Pteridophytes), conform to the same type. It is well known that in spore formation of *Pteris*, the single primordial cell ultimately gives rise to sixty-four spores. It is also known that there are sixteen so-called "spore-mother-cells" in each sporangium, and that from these sixteen cells the final spores are formed. The stage between the first spore cell and the sixteen cells is directly comparable with the "division-period" in animal maturation. The sixteen-cell stage (see next page) is the stage of enlargement and of tetrad-formation and corresponds with the "growth-period." Finally the "maturation-period" is recognized by the two consecutive divisions of the sixteen cells to form the sixty-four spores.

As the maturation phenomena are so closely parallel in plants and animals, it would be of advantage to have the corresponding cells designated by analogous names. In some cases the present botanical names are unwieldy and inappropriate. The "spore-mother-cell" as a designation for the cells of the sixteen-cell stage is incorrect as well as clumsy; for, if we consider the nuclei alone, these cells do not give rise to the spores, but to the "mother-cells" of the spores, and are therefore the "grandmother-cells" of the spores. I propose, therefore, to use the term "primary sporocyte" for the cells of the sixteen-cell stage, and "secondary sporocyte" for cells of the thirty-two-cell stage. These terms are directly analogous to "primary" and "secondary" "oöcyte," and "spermatocyte" in animal cells. The term "sporogonium," which in this connection would be analogous to the term "oögonium" or "spermatogonium" is, unfortunately, already used in a different sense in botanical nomenclature and I shall therefore designate the first eight cells in spore formation as "archesporial cells" in accordance with botanical usage.

C. Observations.

It is beyond the scope of this paper to describe in detail the formation of the sporangium, with its annulus and tapetum, or to describe the degeneration of the tapetal cells. Nor is it necessary to give aminute account of the mitoses leading up to the formation of the sixteen sporocytes. They all agree with the division of the "archesporium" and the number of the chromosomes apparently remains the same, although they are so numerous that it is impossible to give the absolute number. From careful counting in several cases, I estimate the number to be between one hundred and twenty and one hundred and thirty.

The unicellular archesporium, which is destined to give rise to all the spores of the sporangium, can be readily distinguished from the surrounding somatic cells. It is larger, and the chromatin of the nucleus stains much more deeply than that of the other cells. The chromosomes are large and distinctly looped, and in the metaphase of karyokinesis they are split by a longitudinal division (Fig. 17). After each division the daughter-nuclei pass into the resting stage, during which the cell-walls are completely formed and each daughter-cell becomes completely separated. The resting stages are comparatively long and the division stages short.

1. *The growth-period.*

After the sixteen primary sporocytes are formed the nuclei pass as usual into the resting stage (Fig. 1). The nuclei are at first comparatively small (10.3 μ in diameter), the chromatin-reticulum does not stain intensely, and there are usually from one to three or more nucleoli in each. Meantime the tapetal cells degenerate, giving room for growth of the reproductive elements. This growth must begin very soon for the cells in the resting stage (Fig. 1) are not frequently found. When fully grown, the nuclei measure about 14.5 μ in diameter, an increase of nearly 50 per cent. During this enlargement the chromatin reticulum is converted into a delicate moniliform spireme. This is a single thread of chromatin, very much coiled and interwoven and at first distributed evenly throughout the nucleus (Fig. 2). From this condition of extreme delicacy and expansion the chromatin soon passes into a stage of greater localization and the spireme becomes thicker. Evidence of the beginning of concentration can be seen in Fig. 2 an early stage, where the nucleolus has not disappeared. In a later stage, to which Farmer has given the name "Synapsis," the meshes are drawn towards one side of the nucleus into a much more compact chromatin mass (Fig. 3). This mass next becomes loosened and the filaments more or less isolated. In exceptionally favorable preparations the spireme in this stage is seen to be double (Fig. 3 x).

The concentration of the chromatin at the same time with the thickening of the spireme seems to indicate a coalescence and union of the formerly distinct granules of chromatin in the delicate moniliform spireme.

2. *Period of tetrad formation; pseudo-reduction.*

In the case of animals when the spireme thread breaks up into segments destined to form tetrads, the number of these segments is, in general, half the number of chromosomes in the somatic cells. There is a reduction in number of chromatin masses, but the nucleus still contains all the chromatin it held at first, so that actual reduction has not yet taken place. Rückert (1894) has accordingly proposed the expressive term "pseudo-reduction" for this preliminary halving of the number of chromosomes.

Pteris forms no exception to this rule. The double spireme breaks up into short and well defined chromatin segments (Fig. 5 a) each of which gives rise to a tetrad. The number of these segments is difficult to determine; in several cases I counted about sixty. This is about half of the number in somatic cells where, as nearly as I can make out, there are between one hundred and twenty and one hundred and thirty chromosomes. It is an interesting fact that the process of tetrad formation is subject to some variation and does not, apparently, conform exclusively to any one type. This conclusion is based upon the following facts. The spireme segments are, from the beginning, invariably double (Fig. 5 a). The same nuclei contain various modifications of the double segment. Some of them are split in the center while the ends remain connected, giving rise to ring forms (Figs. 4, 5, 19 c). In some there is no separation at all, in others the ends separate, giving rise to "cross" forms (Fig. 6 l and Fig. 19 a) and in still others one half the segment may slide along on the other half till the ends are no longer contiguous (Fig. 6 d and e). There may be still further modifications of the double segment in the same nucleus (Fig. 5 x). In none of the nuclei which I have examined does any of these types predominate; and from their various and diverse shapes it is impossible to regard them as developmental stages of a single type. I am forced, therefore, to the conclusion that, in these ferns, tetrads may be formed in a variety of ways. The various methods can be grouped into three types, which I will describe separately as (a) the "ring type;" (b) the "rod type;" and (c) the "cross type."

a. The "ring type." Almost every primary sporocyte contains from one to several (8 or 9) ring forms in different stages. In some cases the chromatin portion is thin and the opening comparatively large (Fig. 4 c, 5 c, 19 c). In no case is the ring thin and delicate as in *Heterocope robusta* (Rückert, 1893, Fig. 23). The ring stage begins with a lateral bulging of the two halves of the spireme segment (Fig. 6 i); this is followed by the appearance of a furrow at the center. This furrow enlarges until it forms a circular space, and, the ends of the segment remaining attached, the chromatin forms a closed ring (Fig. 19 c). The chromatin then begins to accumulate in four parts, each half of the originally double spireme forming two (Figs. 6 J, 19 c and 20 c). These parts become more and more distinct and individualized; more compact and tightly packed together, until finally the tetrad is completed (Fig. 7). The tetrad is, therefore, derived first, by a longitudinal splitting of the spireme segment, and second, by the transverse splitting of the two halves.

b. The "rod type." The tetrad begins as before with the short and somewhat thickened double spireme-segment, but here no separation of the two parts of the segment takes place (Fig. 5 a). The chromatin segregates at the two ends in four swellings (Fig. 6 b). These swellings enlarge, become more definite and the segments become shorter by the gradual drawing together of the ends. The ends finally round out and tetrads are formed by what would seem to be the simplest method possible.

There are some modifications of this type. In some cases the two halves of the spireme segment slide along on each other until, in an extreme case, the opposite ends may become contiguous (Fig. 6 d, e). The resultant tetrad does not differ essentially from one formed in the simpler manner. There is the same segregation of chromatin at the four ends, the same shortening of the segment and finally the same end result, although at first the tetrad is somewhat distorted. In the rod type, therefore, the tetrad originates first by a longitudinal division of the spireme, and second, by transverse division of the halves and is equivalent in all respects to the tetrad of the "ring type."

c. The "cross type." In this type the halves of the double spireme segment, instead of separating in the centre as in the "ring type," or of remaining parallel to each other as in the "rod type," become separate at the two ends but remain attached to each other in the centre. (Fig. 6 a, l., etc.) These ends separate farther and farther until each half segment forms a loop which lies in contact with the other half segment only at the center of the convex side (Fig. 6 c). It is the opposite of the ring type. In some cases the segregation of the chromatin begins at an early period (Fig. 6 a), and, as separation continues, the segregation becomes more marked, until finally there are four distinct swellings lying at right angles to each other (Fig. 6 c, 19 a). The loops meantime become shorter and shorter, until finally the four parts of the chromosome are brought together, and a tetrad is formed similar in all respects to those of the "ring" and "rod" types (Fig. 6 k).

Like the "rod type," the "cross type" shows some modifications. After the ends have begun to diverge as in the normal cross type, one of the loops may swing around through an angle of 90 degrees on the point of attachment as a pivot (Fig. 6 f). It thus comes to lie in a plane at right angles to its original position. Segregation of the chromatin gives rise to the four parts of the chromosome as before. Various other modifications of this type are found (Fig. 5 x), but in all of them the result is the same. Here, therefore, as in the other types the tetrad originates first by a longitudinal division of the spireme-segment and second by transverse division of the halves.

3. *Period of Reduction.*

It is in this period of spore development that reduction of the chromosomes actually takes place. It begins with the arrangement of the mature tetrads into the nuclear plate of the primary sporocyte spindle. Before this arrangement the tetrads are distributed throughout the nucleus (Fig. 7). The nuclear membrane disappears, and after this, for the first time, it can be clearly seen that the nuclear space is filled with almost parallel spindle fibres (Fig. 8). The latter at this stage could not be traced to definite points at the poles. The tetrads lie in various positions on the spindle fibres (Fig. 9), but they gradually collect at the equator of the spindle. The migration towards the equator of the spindle is clearly shown in Fig. 10 for *Pteris* and Fig. 20 for *Adiantum*, while Fig. 11 shows the completion of the spindle in *Pteris* and the definite formation of the nuclear plate. In this stage the tetrads are closely packed, and are so numerous that counting is impossible. In the early stages, however (Figs. 8 and 10), it can be seen that the number is about sixty.

The compact arrangement of the tetrads in the nuclear plate leaves no chance for orientation. It is impossible, therefore, to tell from this division whether the tetrad divides through the line of original cleavage, or through the secondarily acquired transverse cleavage. In other words, it is impossible to tell whether the division of the primary sporocyte is a reducing or an equation division. There is, however, good reason to regard this as an equation division, and the division of the secondary sporocyte as transverse, and, therefore, as a reducing division. The second mitosis follows closely on the first, but in the short interval the two parts of each dyad, which at first appear like two small balls closely pressed together (Figs. 12 and 21), now become drawn out in the direction of their common axis, which is probably the original longitudinal axis of the spireme-segment (Figs. 13 and 14). It is immaterial in the final spore cells whether the first or the second division is a reducing division in the Weismann sense. That one of them must be is shown by the method of tetrad formation; but, from the manner in which the dyads elongate, the probability is certainly strong that reduction is effected by the second mitosis. The change in shape of the chromosomes in the secondary sporocyte-spindle makes the general appearance of the nuclear plate conform more nearly with that of the somatic cells (cf. Figs. 13 and 18), although they are fundamentally different.

4. *The spore.*

The cylindrical shape of the daughter chromosomes as they come from the division of the dyads in the secondary sporocytes is retained until late in the anaphase (Fig. 14). The resulting four daughter-nuclei lie freely in a single cell which, until the cell-plates are formed, is a syncytium. In the division of multinuclear cells it has been frequently noted that the nuclei are connected by spindle fibres. This occurs in ferns, and long after division, and even as late as the telophase after the cell-plates are formed and the nuclei have gone into the resting stage, fibres can still be seen connecting each nucleus with all the others (Figs. 14 and 15). While the cell-plates are forming, the chromosomes gradually disintegrate and pass into the reticulum although their outlines can be dimly made out even after the reticulum is well formed and the nucleoli have reappeared (Fig. 16).

5. *The centrosome.*

It is extremely difficult to stain, and correspondingly hard to find the centrosomes in this material; even at the spindle-poles its identification is not easy. I was able, however, to make it out in two different stages (Figs. 11, 12 and 13). One of these was in the mitosis of the primary sporocyte, the other in that of the secondary sporocyte. In the first of these the centrosome at the spindle-poles was double (Figs. 11 and 12), in the second it was single (Fig. 13).

II. Tetrad-formation.

In cases where reduction in the Weismann sense is actually known to take place, there have been wide variations in the accounts of the process. It was first described by a former pupil of Weismann's, Ishikawa, who did not find tetrads and who held that reduction in the copepod *Diaptomus* is accomplished by the separation of entire chromosomes. This result is entirely contradictory to the more recent results obtained by the subsequent study of *Diaptomus* and other copepods.

Vom Rath, apparently the first to correctly interpret the formation of tetrads, gave a different account of reduction in the insect *Gryllotalpa*. He found that the spireme is double before it breaks up and that there are half as many of the double segments as there are chromosomes in the somatic cells. The halves of the double segment separate, except at the ends, and a ring is formed. Later the tetrads arise by concentration of the chromatin at four points of the ring, a method by which the four parts of the tetrad originate by longitudinal division represented by the original division of the spireme, and by a transverse division.

Häcker gave still another description of tetrad-formation in *Cyclops strenuus*. His details have been denied by Rückert, who, however, accepted the general results and agreed with him that the tetrad is formed as in *Gryllotalpa* by a longitudinal and a transverse division of the original spireme segments. Rückert (1893 and 1894) has found two modes of tetrad formation, each giving, however, the same results, viz.: the formation of tetrads by a primary longitudinal and a secondary transverse division of the spireme. The first method (*Cyclops*, *Canthocamptus*) agrees almost exactly with what I have here described as the "rod type." The spireme is divided longitudinally before segmentation into half the normal number of chromosomes. The chromatin then begins to collect into a much thicker double rod; the rod then divides transversely and the tetrad is formed by longitudinal and transverse division. The other method described by Rückert takes place in *Heterocope* and *Diaptomus* and agrees very closely with what I have described as the "ring type." The double spireme breaks as before, but the double segment, instead of remaining contiguous throughout, becomes separated in the middle, while the ends alone remain in contact. A ring is thus formed and tetrads arise later by two divisions, one through the diameter of original cleavage, the other at right angles to this line.

Enough has been given in this account to show that certain methods tetrad-formation are characteristic of certain species of animals. Up to the present time it has always been found that the tetrads in a single nucleus are formed by one method, either by the "rod type" or by the "ring type" alone. My observations on the fern, however, show that tetrads in the same nucleus may be formed by both methods or even by a third. From these facts the conclusion seems inevitable that all the types of tetrad-formation mentioned above are merely modifications of the same process and have no significance in themselves so long as a common result is obtained.

It seems remarkable that such obvious structures as tetrads should have been hitherto overlooked in the plant reproductive cells. Many observers have noticed that the mitosis in the sporocyte differs from that of all other cells, whether somatic or archesporial. This difference was early recognized by Guignard and Strasburger. Overton and Belajeff also were struck by the peculiar shape and appearance of the chromosomes in this mitosis; the latter especially described them as agreeing in all particulars with Flemming's account of heterotypical mitosis. Finally Farmer (1895), in speaking of the pollen-mother-cell of *Lilium Martagon*, refers to structures which can be explained only as early stages in tetrad formation: "Die Form der Chromosomen ist sehr unregelmässig, zuweilen erscheinen sie als Bänder, oft als Ringe mit einer oder zwei Protuberanzen, letzteres tritt namentlich in etwas späteren Stadien auf. Ich habe viele Zeit geopfert, mit dem Versuch zu einer festen Entscheidung darüber zu kommen, ob die Ringähnliche Form wirklich primitiv vorhanden oder einer inneren Spaltung zuzuschreiben ist, die das Chromosom noch nicht vollständig getheilt hat. Ich neige stark zu letzterer Annahme und betrachte desshald die Ringform, wo sie verkommt als ein frühes Anzeichen der Langstheilung des Chromosoms" (p. 58). Again he says: "Es braucht kaum bemerkt zu werden, dass diese heterotype Form der Mitose auf die Pollenmutterzellentheilungen sich beschränkt und sich weder in den vegetativen, noch in den früheren Archesporialen Theilungen derselben Pflanze findet" (p. 64). And finally: "Was die zweite Kerntheilung in Pollenmutterkorn betrifft, so zeigt sie gar nichts von den eigenthümlichen (heterotypischen) Vorgänge, welche die erste Mitose characterisiren, sie weicht nur durch die behaltene reducirte Chromosomenzahl von einer vegetativen oder eine frühen Archesporialen Kerntheilung ab. Es ist daher wahrscheinlich, dass die der ersten Theilung besonderen eigenthumlichkeiten mit der plötzlichen Chromosomenzahlveränderung in einer directen und causalen Beziehung stehen" (p. 67).

The still later work of Miss Sargant ('95), on the chromosome of the pollen-mother-cell of *Lilium Martagon*, shows that a transverse division of the chromosomes probably takes place. She does not mention the formation of rings which were described by Farmer as preceding the nuclear plate stage, nor does she mention tetrads. But as Wilson first pointed out ('96 p. 197), her description of the dividing chromosomes give strong reason to believe that these structures are to be interpreted as tetrads.

The fact that so many observers have described phases which suggest more or less clearly the formation of tetrads in different groups of plants, together with my own observations on the ferns, render it probable that further study will show the reduction of chromosomes through tetrad formation to be a phenomenon of as wide occurrence among plants as it is already known to be among animals.

Summary.

1. The spore maturation in Pteridophytes agrees step by step with the maturation of sexual cells in animals.

2. As in animal maturation, the process of spore-formation can be divided into three periods of division, growth and maturation. The *division-period* is the interval between the archesporium and the sixteen-cell stage of the sporangium. The *growth-period* is the interval during which the sixteen cells enlarge and tetrads are formed. The *maturation-period* includes the two successive divisions of the nuclei in the sixteen-cell stage, and the formation of the spores.

3. Different terms are used to designate the cells in the different stages of maturation. Those of the "division-period" are known as the "*archesporial cells.*" Those of the "growth-period" have hitherto been known as the "spore-mother-cells." The term "spore-mother-cell" is, however, inaccurate and clumsy, and I suggest the term *primary sporocyte* in its place, also *secondary sporocyte* for the daughter-cells of the primary sporocyte. These are the mother-cells of the spores and by their subsequent division the sixty-four spores are formed.

4. The "growth-period" is the most important stage in maturation. It begins with a distinct enlargement of the cell. The chromatin then forms a delicate moniliform spireme before the nucleolus has disappeared. A much thicker spireme is subsequently formed from the moniliform thread. The thickened spireme then splits longitudinally. It next breaks up into half as many double spireme-segments as there are chromosomes in the somatic cells; each of these double elements forms a tetrad.

5. Three types of tetrad-formation are found in each nucleus. These may be called the "rod type," the "ring type" and the "cross type." In the first type the halves of the double spireme segment are completely separated; in the second, the halves become separated in the center but remain connected at the ends; in the third type the halves become separated at the ends but remain connected at the centre.

6. In all three types the tetrads are finally formed by a transverse division of the halves of the double spireme-segment, giving reduction in the Weismann sense.

7. These methods of tetrad-formation have no significance in themselves so long as a common result is obtained. They may be considered as modifications of the same process.

Columbia University, Department of Botany,
February 8, 1897.

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Description of Plates 295, 296.

Figures 1–18 are stages in *Pteris*; figures 19–21 are *Adiantum*; all figures are drawn with a Zeiss Camera lucida.

Fig. 1. Early sporocytes in the resting stage subsequent to the last division of the archesporial cells. × 1800.

Fig. 2. Primary sporocyte after growth. Chromatin arranged in a delicate, single, moniliform spireme, nucleolus persistent. × 1800.

Fig. 3. Primary sporocyte with thickened and concentrated spireme. The end (x) is double. × 1800.

Fig. 4. Primary sporocyte showing different stages in tetrad formation. C-ring forms. × 1800.

Fig. 5. Primary sporocyte; portion of nucleus showing stages in tetrad formation. A-double spireme segment; C-ring forms; X-divergent forms. × 2300.

Fig. 6. Various types of tetrad formation; A, B, C, F, G, H, K, L, show the "cross type," D and E the "rod type," I and J the "ring type." × 3600.

Fig. 7. Primary sporocyte with finished tetrads. × 1800.

Fig. 8. Primary sporocyte showing spindle fibres, loss of nuclear membrane, and distribution of the tetrads. × 2300.

Fig. 9. Primary sporocyte section showing fewer tetrads and the arrangement on the spindle fibres. × 2300.

Fig. 10. Primary sporocyte, a prophase showing concentration of the tetrads into the nuclear plate. × 2300.

Fig. 11. Primary sporocyte; metaphase showing completed spindle. C-centrosome. × 2300.

Fig. 12. Primary sporocyte, anaphase showing division of tetrads into dyads. D-dyads. C-centrosome. × 1800.

Fig. 13. Secondary sporocyte; metaphase showing arrangement of elongate dyads in the nuclear plate. C-centrosome. × 1800.

Fig. 14. Late anaphase of the division of the secondary sporocyte showing the four nuclei free in the cell, with connecting spindle fibres. × 2300.

Fig. 15. Early spores. The cell plates have formed; remnants of the spindle fibres can still be seen. × 1800.

Fig. 16. Young spore. Nucleoli have reappeared. × 1800.

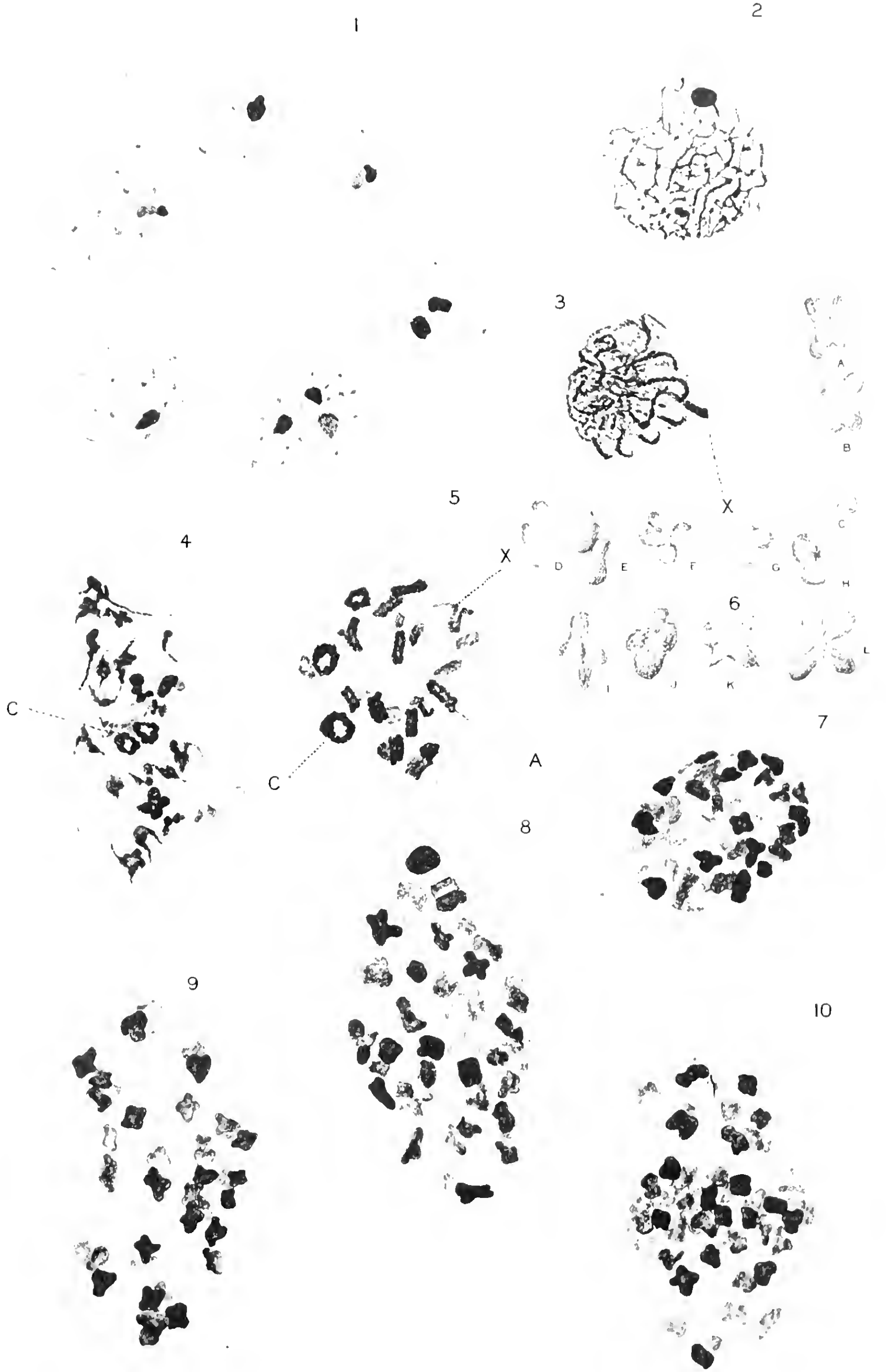
Fig. 17. Primary archesporium; a few of the chromosomes during the early stage of division. They are distinctly double. × 2300.

Fig. 18. Somatic cell from a young fern plant, in division. × 2300.

Fig. 19. Primary sporocyte (*Adiantum*) showing formation of tetrads. C-ring form. A-cross form. × 2300.

Fig. 20. Primary sporocyte showing division of tetrads into the nuclear plate. C-ring forms. × 2300.

Fig. 21. Primary sporocyte showing division of the tetrads to form dyads. (D). × 2300.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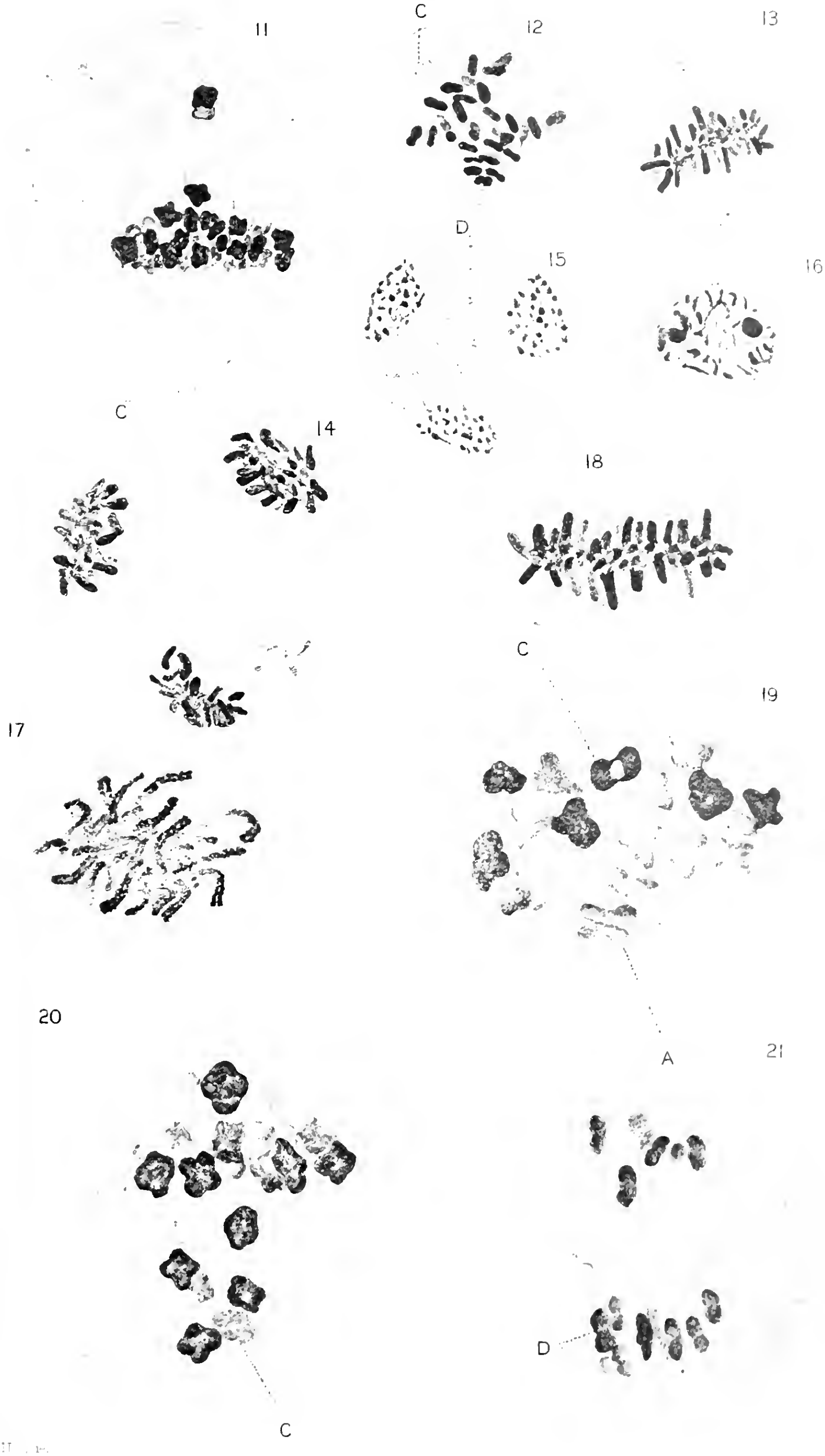
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CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 116.

Studies in the Botany of the Southeastern United States.—IX.

BY JOHN K. SMALL.

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Studies in the Botany of the Southeastern United States.—IX.

By John K. Small.

1. THE SESSILE-FLOWERED TRILLIA OF THE SOUTHERN STATES.*

In the spring of 1896, Professor Underwood and the writer independently became interested in a species of *Trillium* native in the southern Atlantic and the Gulf States.† Professor Underwood collected his material in Alabama, while I received specimens collected in western North Carolina, by my friend Mr. A. M. Huger.

The plant in question, judging both from descriptions and specimens preserved in our larger herbaria, has without exception been included in *Trillium sessile.* As I shall show, this is an error, and was committed by Linnaeus himself and both general botanists, and monographers of this group have apparently followed his disposition of the plants to the present time.

Without doubt the original *Trillium sessile* of Linnaeus‡ was a composite species, for after his description, "Trillium flora sessile erecto," he quotes descriptions from the three authors, Gronovius, Plukenet and Catesby, as follows:

* This study has been furthered by the loan of material from the herbaria of Harvard University and the United States Department of Agriculture.

† After extensive field observations during the spring and summer, Professor Underwood read a paper on the sessile *Trillia* before Section G of the American Association for the Advancement of Science at its last meeting. He expected to finish and publish the results of the study, but, being pressed for time, requested the writer to complete the work already well advanced.

‡ Species Plantarum, 340.

"Paris foliis ternatis, flore sessile erecto. Gron. virg. 44. Solanum virginianum triphyllum, flore tripetalo atropurpureo in foliorum sinu, absque pediculo, sessile. Pluk. alm. 352. t. 111. f. 6. Solanum triphyllum, flore hexapetalo: tribus petalis purpureis, caeteris viridibus reflexis. Catesb. car. 1. p. 50. t. 50."

The habitat given is "Virginia, Carolina." The first of these three descriptions throws little or no light on the subject, but the second and third quotations each refer to a plate. A comparison of these two plates indicates a great discrepancy, the figure of Plukenet representing a small plant with oval leaves, while the Catesby drawing illustrates a large robust plant with ovate-lanceolate leaves. If only these two plates had to be considered, there would be no doubt not only as to there being two distinct species involved, but we should have no trouble in deciding to which plant the name *Trillium sessile* must be applied. The first quoted description being wholly indefinite, left this important question in doubt. In order to settle this point definitely, Dr. Britton sent specimens of both the small and large plants to Mr. Edmund G. Baker, at the British Museum, and I can not do better than print his reply: " * * * * We have the Gronovian plant and also a plant in the Plukenet Herbarium, written up by Plukenet, but not the one apparently the figure was done from, as you will see from the tracing I enclose. The Gronovian and Plukenet plants are fairly similar and more like no. 2 (the small plant with oval leaves) than the much larger no. 1 (the large plant with ovate-lanceolate leaves). Neither of the specimens are particularly good ones, but I have tried to make tracings of them, such as they are, these will show the outline of the leaf if they do nothing else. You may like to have exact measurements of the Plukenet plant: Leaves broadly oval, 2 in. long, breadth $1\frac{7}{12}$ in., sepals $\frac{5}{6}$ in., petals $\frac{11}{12}$ in. * * * * ."

Thus we see that the first and second quoted descriptions in the Species Plantarum are represented by specimens which agree with each other in all essential particulars, while the third quotation is founded wholly on a plate, which represents a species totally distinct from that on which the first and second descriptions were founded. Therefore the name *Trillium sessile* must be associated with the small oval-leaved plant, and the large plant must receive a name, which will appear in the appended synopsis. The solution of this ong-standing error naturally excited my interest in this whole group of *Trillium*, and a study of the different species leads me to print the following key and specific descriptions which, I hope, will lead to a better understanding of these interesting plants.

As far as I can see, this group of *Trillium* has always been very unfairly treated; most authors seem to have taken it for granted that the number of species was very limited and that that number could not be naturally increased. If an author did put his convictions in print, described a new species, pointed out excellent characters for a species and distributed specimens, that species was almost certain to find itself in synonymy or reduced to varieta, rank of another species at an early date. This state of affairs continued and reached a climax in Dr. Watson's treatment of the group in his revision of the North American Liliaceae,* where only two forms are given specific rank, while the rest are included in the synonymy or varietal ranks under a much distorted nomenclature, for example, *Trillium viride* Beck appears as a synonym of *Trillium sessile* L., *Trillium discolor* Wray appears as a variety of *Trillium sessile* under the new name *Wrayi*, *Trillium viridescens* Nutt. (*T. viride* Beck) also appears as a variety of the Linnaean species under the new name *Nuttallii* and *Trillium lanceolatum* Boykin mss. is set down as a variety of *Trillium recurvatum*, which is fortunate enough to have retained specific standing.

Key to the Species.

Petals sessile, of one color throughout.
  Sepals oblong or oblong lanceolate; petals broadly spatulate. 1. *T. discolor.*
  Sepals lanceolate; petals lanceolate, elliptic or oblanceolate.
    Leaves oval or suborbicular, 4–8 cm. long; anthers 3–4 times longer than the filaments; styles elongated, nearly straight. 2. *T. sessile.*
    Leaves ovate-lanceolate to ovate-orbicular, 8–18 cm. long; anthers subsessile; styles almost wanting, stigmas recurved. 3. *T. Underwoodii.*
Petals clawed, the blade and claw often of different colors.
  Leaves sessile; blades of the petals linear or linear-oblong.
    Stems rough pubescent at least above; leaves ovate or oblong; sepals 2.5–5 cm. long; filaments—$\frac{1}{4}$–$\frac{1}{3}$ shorter than the anthers. 4. *T. viride.*
    Stems smooth; leaves lanceolate or elliptic; sepals 2–2.5 cm. long; filaments about as long as the anthers. 5. *T. lanceolatum.*
  Leaves petioled; blades of the petals ovate, elliptic or obovate. 6. *T. recurvatum.*

* Proc. Am. Acad. 14: 213–303.

1. Trillium discolor Wray; Hook. Bot. Mag. *pl. 3097.* 1831.*

Trillium sessile var. *Wrayi* S. Wats. Proc. Am. Acad. **14**: 273. 1879.

Perennial by a rootstock, bright green, glabrous. Stems erect, 1–2 dm. tall, smooth; leaves oval, 6–7 cm. long, obtuse, or short-acuminate, 3–5-nerved, mottled, rounded at the base, sessile; flowers sessile; sepals oblong or oblong-lanceolate, 2 cm. long, obtuse or acute, spreading; petals broadly spatulate, about 1/3 longer than the sepals, greenish, sessile, rounded and one prominently apiculate at the apex; stamens less than 1/2 as long as the petals, the filaments nearly wanting; berry not seen.

Georgia.

Apparently a rare species and not lately collected, but very distinct, differing from all its relatives in the peculiar broadly spatulate petals, one of which is distinctly apiculate.

2. Trillium sessile L. Sp. Pl. 340. 1753.

Perennial by an erect or ascending corm-like rootstock, deep green, glabrous. Stems solitary or clustered, erect, 1–2 dm. tall, slender; leaves oval or suborbicular, 4–8 cm. long, obtuse or acute, rounded at the base, sessile, 3–5 nerved, not mottled; flowers sessile; sepals lanceolate, 2–3 cm. long, acute or acutish; petals narrowly elliptic, slightly shorter than or longer than the sepals, sessile, acutish, purple; stamens about 1/2 as long as the petals; filaments dilated at the base, 1/3–1/4 shorter than the anthers; styles elongated, nearly straight, berry not seen.

In woods, Pennsylvania to Minnesota, south to Florida and Mississippi. April and May.

3. Trillium Underwoodii n. sp.

Perennial by a horizontal rootstock, bright green, glabrous. Stems solitary or clustered, 1–3 dm. tall, stout; leaves varying from ovate-lanceolate to ovate-orbicular, 8–18 cm., long, acute or short-acuminate, undulate, sometimes crisped, with a velvety lustre, mottled with 3 shades of green, rounded or subcordate at the base, sessile; flowers sessile, musk-scented; sepals lanceolate, 4.5–5.5 cm. long, obtuse or acute, erect or spreading, green or purplish-green; petals lanceolate, elliptic or oblanceolate, 5.5–8.5 cm. long, sessile, acute or obtuse, erect, purple; stamens 3–4 times shorter than the petals, filaments very short, anthers 1.5–2 cm. long, subsessile; styles almost wanting; stigmas recurved; berry ovoid.

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* I am indebted to Dr. B. L. Robinson for a tracing of the original plate of *Trillium discolor*.

In woods and fields, North Carolina to Tennessee, south to Florida and Alabama. April and May. Ascends to 950 metres in North Carolina. *Trillium sessile* and *Trillium Underwoodii* are remarkably constant in comparative size. The two species can readily be segregated on size and habit alone and of course comparative measurements of organs would serve as an excellent basis of separation. But this is not necessary since we have such good specific characters as exist in the flower, especially as respects the stamens and styles.

4. TRILLIUM VIRIDE Beck, Am. Jour. Sci. 11: 178. 1826.

Trillium viridescens Nutt. Trans. Am. Philos. Soc. (II.) 5: 155. 1837.

Trillium sessile var. *Nuttallii* S. Wats. Proc. Am. Acad. 14: 273. 1879.

Perennial by a short corm-like rootstock, bright green, more or less pubescent. Stems solitary, or several together, 1–4 dm. tall, purple, rough-pubescent at least near the top; leaves oblong, ovate, or broadly ovate, 5–11 cm. long, acute or obtusish, 3–5-nerved, usually blotched, more or less pubescent on the nerves beneath, abruptly short-attenuate at the base; flowers sessile; sepals linear or linear-lanceolate, 2.5–5 cm. long, bright green, acute or obtuse, erect or spreading; petals clawed, the blades linear or nearly so, 2.5–6 cm. long, surpassing the sepals, light green or purplish green, acute or obtuse, on brown or purple claws; stamens about ⅓ as long as the petals; filaments flattened, $\frac{1}{4}$–$\frac{1}{5}$ shorter than the anthers; berry not seen.

In woods and glades, Missouri to Tennessee, south to Mississippi and Arkansas. April and May.

Prof. Beck published a good description of this species in the year 1826. Mr. Nuttall described an apparently extreme form of the same species eleven years later. With these two full descriptions and the original specimens of Mr. Nuttall extant, it seems strange that *Trillium viride* Beck, and *Trillium viridescens* Nutt., being one and the same species, should, on the one hand, be made a synonym and on the other a variety of a species to which it is only distantly related; the clawed petals, among many other characters, primarily prevent it being associated with *Trillium sessile.* Its true relationship is with *Trillium recurvatum.*

Mr. Nuttall collected the original specimens of *Trillium viri-*

descens in Arkansas, and of this collection there are good specimens preserved. Prof. Beck's plants came from St. Louis and, although I have not seen his original specimens, we have a specimen from the same place collected by Riehl in 1841, and, in addition to this, Mr. Henry Eggert has sent me excellent material from the vicinity of St. Louis collected during the past few years. All these plants, as well as those from the extremities of the known geographic range cited above, agree with each other in essential specific characters.

5. TRILLIUM LANCEOLATUM Boykin; S. Wats. Proc. Am. Acad. 14: 274. As synonym. 1879.

Trillium recurvatum var. (?) *lanceolatum* S. Wats. Proc. Am Acad. 14: 273. 1879.

Perennial by a rootstock, bright green, glabrous. Stems erect, 1–4 cm. long, slender, purplish, smooth; leaves lanceolate or elliptic, 7–9 cm. long, acute or acutish, more or less constricted at the base, sessile; flowers sessile; sepals linear or linear-lanceolate, 2–2.5 cm. long, acute, green, spreading; petals clawed, 3–3.5 cm. long, the blades linear or linear-oblong, acute, the claws about twice as long as blades; stamens about ⅓ as long as the petals; filaments about as long as the more or less incurved anthers; berry not seen.

In moist woodlands and river bottoms, Georgia to Alabama, and Louisiana. (?) April and May.

The following label accompanying Dr. Boykins' original specimen may be of interest: "*Trillium lanceolatum*. This is certainly a new species of sessile *Trillium*. It grows universally in stiff clayey river bottoms. Flowers March and April. The fruit is more bellied than S. Trillium, and deep grooving formed by the stamina, rendering it hexagonal. Stamina incurved."

6. TRILLIUM RECURVATUM Beck, Am. Journ. Sci. 11: 178. 1826.

Trillium unguiculatum Nutt. Trans. Am. Philos. Soc. (II.) 5: 154. 1837.

Perennial by a short horizontal rootstock, light green, glabrous. Stems solitary, or several together, 1–4 dm. tall, smooth, usually slender; leaves petioled, the blades ovate-lanceolate, oval or suborbicular, obtuse or acute, 5–9 cm. long, rounded or sub-cordate at the base or rarely attenuate, often mottled; petioles winged, several times shorter than the blades; flowers sessile, purple; sepals lanceolate, 2–3 cm. long, acute, finally deflexed; petals clawed, the blades ovate, obovate or elliptic, usually acute, about twice longer than the claws; stamens hardly ½ as long as the petals; filaments about ½ or ⅓ as long as the more or less incurved anthers; berry not seen.

In woods, Ohio to Minnesota, south to Mississippi and Arkansas. April and May.

2. NOTES ON CRITICAL SPECIES.

Iris verna L. Sp. Pl. 39. 1753.

I have seen two collections of the spring Iris during the past season, both from North Carolina; the one was made by Mr. A. M. Huger in the mountains and the other by myself in the central part of the State. I find that two of its striking features have not been recorded: first, the remarkable elongation of the leaves, which often reach a length of 3–4 decimeters, and second, the odor of the flowers, which almost exactly imitates the fragrance of sweet violets.

Anemone trifolia L. Sp. Pl. 540. 1753.

While walking along a small stream just west of the Falls of the Yadkin river, last spring I was astonished to find fine plants of *Anemone trifolia*. The species has only been known to exist in America on the higher parts of the Alleghanies, chiefly in the Southern States, but here, in the central part of North Carolina at an elevation of only 200–300 feet above the level of the sea, the species appears as typical as anywhere.

Cardamine parviflora L. Sp. Pl. Ed. 2, 914. 1763.

Virginia seems to have been the southern recorded limit for this species but now Mr. A. M. Huger sends us good specimens from the mountains of Polk County, North Carolina.

Diamorpha pusilla Nutt. Gen. 1: 293. 1818.

The geographic range of this curious plant is gradually expanding. I have recently found the species at various points in northern Georgia and in 1894 and 1895 met with it on Dunn's Mountain in Rowan County, North Carolina. The outlying stations of its distribution as we have it represented by specimens are:

Cumberland Mountains, Tennessee, Prof. Kirby Smith.
Mountains of North Carolina, Mr. G. R. Vasey.
Habersham County, Georgia, Mr. Buckley.
Warren County, Georgia, Dr. Chapman.
Stone Mountain and vicinity, Georgia, various collectors.

WALDSTEINIA FRAGARIOIDES (Michx.) Tratt. Ros. Mon. 3: 107. 1823.

Like *Anemone trifolia* this is normally an Alleghanian species, but I have found quantities of it in the central part of North Carolina growing in dark ravines which branch from the cañon at the Falls of the Yadkin. The altitude of the locality is little over 150 feet.

OXALIS RECURVA Ell. Bot. S. C. & Ga. 1: 526. 1821.

During the summer of 1895 I collected a few specimens of this beautiful and strongly characterized *Oxalis* at Stone Mountain and in the vicinity of Augusta, Georgia.

MONOTROPSIS ODORATA Ell. Bot. S. C. & Ga. 1: 479. 1817.

This rare plant has lately been rediscovered by Mr. A. M. Huger on the mountains of Polk County, North Carolina.

SCUTELLARIA CAMPESTRIS Britton, Mem. Torr. Club. 5: 283. 1894.

In former papers of this series I have reported a number of typically prairie plants which occur east of the Appalachian mountain system ; *Scutellaria campestris* must now be added to the increasing list. In April, 1896, I found several patches above the bluffs at the Falls of the Yadkin River, North Carolina. The latest record of its distribution is given by Drs. Watson and Coulter* as southern Illinois and Kansas. Both Prof. Bain and Mr. Bicknell have collected specimens in Tennessee. It is an excellent species and doubtless has a considerably wider range than our present material indicates.

3. NOTES ON EPILOBIACEAE.

The genus *Ludwigia* as it is now generally interpreted has always seemed to me to contain too many distinct generic types.

* A. Gray, Man. Ed. 6. 418.

I think Linnaeus' idea of holding *Isnardia palustris* generically separate from *Ludwigia alternifolia* is the proper way of disposing of these widely divergent species and their respective relatives. There are three clear generic lines in *Ludwigia* as it is limited by most authors and I think it is much more satisfactory to treat these groups as separate genera than to associate them as subgenera in a composite genus.

I append a synopsis which will serve to emphasize the diagnostic characters:

Leaves opposite; stems prostrate or decumbent, creeping or floating.
  Flowers sessile; petals wanting or very small; leaves petioled; capsules short, sessile, straight, with a flat or depressed top. 1. *Isnardia.*
  Flowers long-stalked; petals large and conspicuous; leaves sessile; capsules elongated, long-stalked, curved, with a prominent 4-lobed stylopodium. 2. *Ludwigantha.*
Leaves alternate; stems erect or ascending. 3. *Ludwigia.*

1. ISNARDIA L. Sp. Pl. 120. 1753.

Key to the Species.

Petals usually none; capsules 2.5–4 mm. long.
  Pubescent; capsules 2.5–3 mm. long. 1. *I. spathulata.*
  Glabrous; capsules 3–4 mm. long. 2. *I. palutris.*
Petals usually present; capsules 6–7 mm. long. 3. *I. natans.*

1. Isnardia spathulata (T. & G.).

Ludwigia spathulata T. & G. Fl. N. A. 1: 526. 1840.
Around pine barren ponds, middle Florida.

2. Isnardia palustris L. Sp. Pl. 120. 1753.

Ludwigia apetala Walt. Fl. Car. 89. 1788.
Ludwigia nitida Michx. Fl. Bor. Am. 1: 57. 1803.
Ludwigia palustris Ell. Bot. S.C. & Ga. 1: 211. 1817.
Isnardia palustris var. *Americana* DC. Prodr. 3: 61. 1828.
Isnardia ascendens Hall; Eaton & Wr. N. A. Bot. 285. 1840.
Ditches, streams and ponds, throughout eastern North America.

3. Isnardia natans (Ell.).

Ludwigia natans Ell. Bot. S. C. & Ga. 1: 518. 1817.
Streams and marshes, North Carolina to Florida and Mexico.

2. LUDWIGIANTHA.

[*Ludwigia*, section *Ludwigiantha* T. & G. Fl. N. A. 1: 526. 1840.]

1. Ludwigiantha arcuata (Walt.).

Ludwigia arcuata Walt. Fl. Car. 89. 1788.
Ludwigia pedunculosa Michx. Fl. Bor. Am. 1: 88. 1803.
Isnardia pedunculosa DC. Prodr. 3: 60. 1828.
Swamps and marshes, Virginia to Florida.

3. LUDWIGIA L. Sp. Pl. 118. 1753.

Represented by fifteen species in the southern United States.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 117.

New or noteworthy American Grasses.—VI.

BY GEO. V. NASH.

[Reprinted from THE BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 24, No. 4, April 24, 1897.]

New or noteworthy American Grasses.—VI.

By Geo. V. Nash.

Paspalum bifidum (A. Bertol.)

Panicum Floridanum Trin. Mem. Acad. St. Petersb. (VI.) 3: Pt. 2, 248. 1834. Not *Paspalum Floridanum* Mx. 1803.

Panicum bifidum A. Bertol. in Mem. Acad. Sci. Bolog. 2: 598. *pl. 41. f. 2, e–h.* 1850.

Panicum Alabamense Trin.; Steud. Syn. Pl. Gram. 64. 1855.

Paspalum racemulosum Nutt.; Chapm. Fl. S. St. 571. 1860.

Paspalum interruptum Wood, Classbook, 783. 1861.

The above seems to be the oldest available name for this plant, the *Panicum Floridanum* of Trinius being excluded by the *Paspalum* of the same name previously published by Michaux. The excellent plate and description of Bertoloni, and the fact that his plant was from Alabama, leaves little to be desired in its identification. I have been unable to ascertain where Dr. Chapman secured the name of *P. racemulosum* Nutt. The publication by Nuttall of such a name I have failed to discover up to the present. The only name resembling that accredited to Nuttall by Chapman is *P. racemosum*, published by the former in the Transactions of the American Philosophical Society ((II.) 5: 145. 1837), but this is antedated by that of Lamarck. Nuttall secured his plant in southeastern Indian Territory, and just what he had I am as yet unable to determine. From a comparison of our plant with his description, I think it will become apparent at once that whatever plant he did have, it was some other than that which has been known for so long as *Paspalum racemulosum* Nutt. The racemes in his species are described as "brevibus" and the rachis as "pilosis," neither of which characters are to be found in our plant, which has the racemes exceptionally long for this genus. "Clavellate receptacle of the flowers pilose" and "calix villous" are surely not descriptive of these parts in this grass, the spikelets of which are very glabrous and the pedicels only puberulent.

There is in the herbarium of Columbia University a specimen ticketed as follows: "'Panicum Alabamense' Trin. in lit. 11. Jul. 1832. Alabama, Dr. H. Gates, 1831." This is apparently in Dr. Torrey's hand writing, and is pretty clear evidence as to the plant of Trinius published by Steudel. I can discover no essential differences between it and *Paspalum bifidum.* The leaves are somewhat broader and the racemes more numerous, but the habit, character of the spikelets, racemes and pubescence, and its distribution are the same. Other specimens from the Gulf States are similar to the one labeled as above.

Judging from the description given by Prof. Beal in Grasses of North America (2: 87, 1896), I take the *P. racemosum* of that work, which he has accredited to Lamarck, to be this plant. I am at a loss to understand, if the description has been seen by him, why he should adopt this name, as a mere casual comparison of Lamarck's description with our plant would show the error of such a decision. The *P. racemosum* Lam., was originally published in his Illustrations (1 : 176), but a much more extended description, in which a reference is made to the first publication, is given in the Encyclopedia Methodique (5 : 32), where it is stated that the plant is remarkable for its branching culms, and, further, that the inflorescence is composed of a large number of short spikes, 40–50, and that the rachis is flat. He also remarks that his plant came originally from Peru. This would hardly describe the grass which I think Prof. Beal had in mind, in which the culms are never branching but always simple, the racemes unusually long for this genus and erect, and the rachis somewhat triquetrous and narrow but not flat. Moreover, one would hardly expect to find native in the southern Atlantic and Gulf States a plant which is indigenous to Peru.

Panicum Bicknellii n. sp.

Whole plant, with the exceptions noted below, smooth and glabrous. Culms erect, or sometimes decumbent, slender, 2–4 dm. tall, at length somewhat branched, the lower internodes puberulent, the nodes sparingly barbed; sheaths generally longer than the internodes, ciliate on the margins, the lowermost pubescent; ligule a fringe of very short hairs; leaves elongated, increasing in length toward the top of the culm, erect, linear, acuminate at the apex, narrowed toward the ciliate base, scabrous on the margins, 7–9 nerved, the midnerve prominent at the base, the primary leaves 8–16 cm. long, 5–10 mm. wide, the uppermost one usually about equalling the panicle, the leaves on the branches shorter, the upper ones much exceeding the panicle; primary panicles ovate, 6–8 cm. in length, the main axis scabrous as are also the ascending slightly flexuous branches, the secondary panicle much smaller with usually appressed branches; spikelets obovate, obscurely pointed, 2.5–3 mm. long, the first scale broadly ovate or triangular, acutish, one quarter as long as the spikelet, sparsely pubescent, 1-nerved, the second and third scales membranous, equal in length, 9-nerved, pubescent with short spreading hairs, the latter enclosing a hyaline palet about one-half its length, the fourth scale chartaceous, yellowish, oval, obtusely apiculate, enclosing a palet of equal length and similar texture.

The type specimens were collected by Mr. Eugene P. Bicknell, in whose honor I take pleasure in naming it, in Bronx Park, on July 21, 1895. It was also obtained by Dr. Thomas C. Porter, on the slate hills near Chambersburg, Pennsylvania, on July 30, 1896.

A most peculiar grass, resembling much in habit *P. depauperatum*, and evidently allied to it, but the leaves are much broader and of a different shape and the spikelets smaller and but obscurely pointed.

Panicum Brittoni n. sp.

Whole plant, with the exception of the spikelets, smooth and glabrous. Culms coarsely striate, densely caespitose, slender, erect, rigid, 1–2 dm. tall, simple or sparingly branched; sheaths closely embracing the culm, striate, less than one-half the length of the internodes; ligule a ring of short hairs, about .5 mm. long; leaves longer than the sheaths, the basal ones broadly lanceolate, more or less spreading, 1.5 cm. long or less, 3–4 mm. wide, those on the culm three in number, the middle one the longest, 1–3 cm. long, 1.5–3 mm. wide, strictly erect, acuminate at the apex, generally somewhat narrowed toward the rounded base, primary nerves 5–7; panicle broadly ovate, 2–3 cm. long, the branches spreading or ascending, the lower ones 1–2 cm. long, the ultimate divisions sparingly scabrous, twice as long as the spikelets or longer; spikelets obovoid, or nearly oval, obtuse, about 1.3 mm. long, the first scale about one-third as long as the spikelet, membranous, usually purplish, glabrous or sparingly pubescent, acutish, the second and third scales equal in length, membranous, broadly oval, 7-nerved, densely pubescent with slightly ascending hairs, the third scale enclosing a hyaline palet about one-half its length, the fourth scale chartaceous, yellowish, oval, obtusely apiculate, enclosing a palet of equal length and similar texture.

In moist sand in the "pine barrens" at Forked River, N. J. Collected by Dr. Britton during an excursion of the Torrey Botanical Club to that region May 29–June 2, 1896.

PANICUM CILIIFERUM n. sp.

Culms caespitose, 2–8 dm. tall, erect, at length much branched and decumbent, hirsute, except a naked ring below the barbed nodes, with ascending or nearly appressed hairs, which are usually more scanty at the summit or nearly wanting. Sheaths papillose-hirsute with ascending or nearly appressed hairs, the basal ones crowded, the remainder shorter than the internodes; ligule a ring of hairs about 1 mm. long, often with an upper supplemental row of much longer hairs; leaves rough and pubescent on the lower surface with short rigid appressed hairs, at least at first, the upper surface smooth and glabrous, or sometimes a few scattered long hairs near the base, ciliate with ascending hairs, 9–11-nerved, rounded at the base, acuminate at the apex, oblong-lanceolate to lanceolate, erect or ascending, those toward the base of the culm more and more spreading, shorter and broader, the primary leaves 2.5–9 cm. long, 3–12 mm. wide, those on the branches 6 cm. long or less, 2–5 mm. wide; mature primary panicle broadly ovate, 7–9 cm. long, 6–10 cm. wide, the branches spreading or slightly ascending, the longer 5–6 cm. in length, the panicles on the branches much smaller and exceeded by the leaves, with the bases included; spikelets obovate, somewhat acute, 3 mm. long, the first scale glabrous, about one-half as long as the spikelet, 1–3-nerved, acute or obtuse, or sometimes 3-toothed, the second and third scales equal in length, 9-nerved, strongly pubescent with somewhat ascending hairs, the latter scale enclosing a hyaline palet about one-half its length, the fourth scale chartaceous, oval, obtusely acute, enclosing a palet of equal length and similar texture.

Type collected by the writer in the "high pine land" at Eustis, Lake Co., Florida, March 12–31, 1894, no. 147. Nos. 27, 75, 79, 94, 96, 103, 1118, 1231, and 1518 of the same collection also belong here; as well as no. 1857, collected in the same place in 1895, and well representing the late and much-branched state.

The harsher papillose pubescence, the broader and shorter leaves, glabrous above, and the larger more open panicle readily separate this from *P. malacon*, which is described below.

I was at first inclined to consider this the *P. ovale* of Elliott, but after a careful comparison with the description and with a specimen so named by Elliott, I feel justified in the above disposition of it.

PANICUM GLABRIFOLIUM n. sp.

Whole plant, except just below the lower nodes, smooth and glabrous and somewhat shining, especially the panicle and spikelets. Culms caespitose, 1.5–4 dm. tall, erect, rigid, slender, leafy to the top, the longer culms pubescent for a greater or less distance below the lower nodes, at length somewhat branched; nodes purplish, the lower ones generally upwardly barbed; sheaths strongly striate, the lowermost ones pubescent, particularly at the base, 3 cm. long or less, closely embracing the culm, a tuft of hairs on each margin at the apex; ligule a fringe of hairs .5 mm. long; leaves narrowly linear, 7–9-nerved, erect, rigid, thickish, long acuminate, narrowed toward the base, those on the sterile shoots 15 cm. long or less, 3–4 mm. wide, those on the fruiting culms 3–9 cm. long, 1–3 mm. wide; panicle ovate, 4–6 cm. long, 3–4 cm. wide, its branches spreading or somewhat ascending, single, the longer branches about 2 cm. long, bearing 3 or 4 distant ultimate divergent divisions which are 2–6 times as long as the spikelets; spikelets slightly exceeding .5 mm. in length, tinged with purple, obovate, the first scale less than one-half the length of the spikelet, membranous, orbicular-ovate, obtuse, 1-nerved, the second and third scales broadly oval, membranous, 5–7-nerved, the latter enclosing a hyaline palet one-half its length, the fourth scale oval, chartaceous, white, enclosing a palet of equal ength and similar texture.

Collected by the writer in the "flatwoods" at Tampa, Florida, on August 20, 1895, no. 2415a. It grows in dense tufts, the long narrow erect leaves and the wiry culms giving it a striking appearance.

PANICUM LINDHEIMERI n. sp.

Whole plant, with the exception of the lower sheaths, usually the lower internodes, and the spikelets, smooth and glabrous. Culms slender, erect, at length branched, the lower internodes sparingly papillose-hirsute, or sometimes glabrous; nodes often barbed with spreading or somewhat reflexed hairs; sheaths shorter than the internodes, somewhat loosely embracing the culms, ciliate on the margins, the lower ones sparingly papillose-hirsute; ligule a fringe of hairs about 2 mm. long; leaves ascending, 2–7 cm. long, 4–12 mm. wide, thickish, narrowly oblong-lanceolate, acute at the apex, rounded or truncate at the somewhat clasping base, 7–9-nerved, the margins scabrous; primary panicle orbicular-ovate, 4–5 cm. long, its branches spreading, the longer 2–3 cm. long, single, dividing at or near the base into 3–5 branches which subdivide into 1–3 branchlets, these usually appressed ultimate divisions rarely exceeding twice the length of the spikelets, the secondary panicles somewhat smaller; spikelets obovate, 1.5 mm. long, the first scale about one-third as long as the spikelet, white, glabrous, broader than long, rounded or almost truncate at the apex, sometimes slightly apiculate, 1-nerved, the second and third scales equal, membranous, yellowish green, broadly oval, 9-nerved; strongly pubescent with spreading hairs, the latter enclosing a hyaline palet one-half its length, the fourth scale chartaceous, broadly oval, yellowish white, enclosing a palet of equal length and similar texture.

The type was collected by F. Lindheimer in 1846, no. 565. The following also are to be referred here:

Heller, Kerrville, Kerr Co., Texas, 1894, no. 1752.

Nealley, Base of House Mt., McCulloch Co., Texas, June, 1890.

Wright, New Mexico, no. 2085.

Panicum malacon n. sp.

Whole plant often purplish, pubescent with white ascending hairs, those on the sheaths and culms longer, scantier on the upper sheaths and the upper part of the culms, the pubescence of the surfaces of the leaves dense and short. Culms caespitose, at first simple, erect, later branching at all the nodes and decumbent at the base; nodes barbed with spreading hairs; sheaths loosely embracing the culm, shorter than the internodes in the simple state, in the branching condition much crowded; ligule a fringe of hairs about 1 mm. long; leaves firm, rigid, sometimes sparingly ciliate, linear, acuminate at the apex, truncate or somewhat rounded at the base, 5–9-nerved, the midnerve prominent on both surfaces, the primary leaves 3–11 cm. long, 3–7 mm. wide, ascending, or the upper ones erect, those on the branches strictly erect, 5 cm. long or less, 3–4 mm. wide; primary panicle but little exserted, 7–10 cm. long, 2–4 cm. wide, its branches ascending or erect, the ultimate divisions 3–10 times as long as the spikelets, appressed to the branches, capillary but rigid, the lower and longer branches 4–6 cm. long, usually more contracted than those on the upper part of the panicle; spikelets obovate, a little exceeding 3 mm. in length, the first scale more or less pubescent, about one-half as long as the spikelet and 3–5 nerved, acute, the second and third scales membranous, equal, 9-nerved, densely pubescent with ascending hairs, the latter scale enclosing a hyaline palet about one-half its length, the fourth scale chartaceous, oval, enclosing a palet of equal length and similar texture.

Collected by the writer in the "high pine land" at Eustis, Lake County, Florida, May 1–15, 1894, no. 628, and distributed as *P. pauciflorum* Ell. It appears quite distinct from a specimen of that species, so named by Elliott, preserved in the herbarium of Columbia University, the character of the pubescence and the spikelets serving well to distinguish it.

PANICUM MALACOPHYLLUM n. sp.

Whole plant, except the leaves, papillose-hirsute with rather soft long spreading hairs. Culms 4 dm. tall or less, erect, at length branching toward the summit; nodes densely barbed with reflexed hairs; ligule a ring of hairs about 1 mm. long; sheaths shorter than the internodes, loosely embracing the culms; leaves erect or ascending, narrowly oblong-lanceolate, narrowed toward the rounded base, acuminate at the apex, softly pubescent on both surfaces, rough on the margins, 7-nerved, the primary leaves 5–8 cm. long, 4–11 mm. wide, the leaves of the branches 4 cm. long or less, 3–5 mm. wide; panicle slightly exserted, ovate, 3–5 cm. long, the branches spreading, somewhat flexuous, the lower 1.5–2 cm. long, bearing 4–8 spikelets on pedicels shorter than themselves; spikelets obovate, 3–3.5 mm. long, acute, the outer three scales membranous, densely pubescent with long spreading hairs, the first scale orbicular-ovate, acute, about two-fifths as long as the spikelet, 1-nerved, the second and third scales equal in length, broadly oval, 9-nerved, acute, the latter enclosing a hyaline palet about one-half its length, the fourth scale chartaceous, broadly oval, yellowish white, enclosing a palet of equal length and similar texture.

Type collected by Mr. B. F. Bush on May 19, 1895, at Sapulpa, Indian Territory, no. 1228. The grass secured by Dr. Edward Palmer in 1868, on the False Washita, between Fort Cobb and Fort Arbuckle, Indian Territory, no. 383, belongs here. Dr. Gattinger also obtained it in the cedar barrens of Tennessee, in May, 1880.

This appears to be sufficiently distinct from *P. Scribnerianum* to warrant giving it specific rank. Its more slender habit, the long hirsute pubescence of the culm and the panicle, including its branches and pedicels, the densely barbed nodes, the softly pubescent leaves, and the somewhat smaller acute spikelets which are densely pubescent with hirsute hairs, appear to make the above disposition of the plant necessary. In *P. Scribnerianum* the pubescence is much more rigid, the culm and panicle glabrous, or rarely with a few scattered hairs, and the leaves and spikelets glabrous, or the latter occasionally somewhat pubescent with shorter hairs.

Dr. Palmer's no. 382, collected probably in the same locality as his no. 383, referred to above, is *P. Scribnerianum*, and strikingly shows the differences, already noted above, between this and *P. malacophyllum*, when growing in the same region.

PANICUM NEURANTHUM Grisebach, Cat. Pl. Cub. 232. 1866.

There is no doubt as to the occurrence of this species in the United States, its range extending, so far as the specimens to which I have had access indicate, from southeastern Virginia, thus bringing it into the region covered by the Illustrated Flora, to Florida, and westward to Louisiana.

Grisebach based his species on Wright's Cuban Collection no. 3453. This exactly matches the plant collected by A. H. Curtiss, in Duval Co., Florida, no. 3567*, and also my no. 1243, secured at Eustis, in the same State, during July, 1894.

I would refer to this species, in addition to those already cited above, the following:

N. L. Britton, Virginia Beach, Va., Sept. 10, 1895.

Ravenal, Aiken, S. C., May 28, 1867.

J. K. Small, near Valdosta, Lowndes Co., Ga., June 6–12, 1895.

J. H. Simpson, Sanibel Island, Fla., March, 1891, no. 298.

Chapman, Appalachicola, Fla.

S. M. Tracy, Ocean Springs, Miss., Aug. 3, 1889, no. 421.

C. L. Pollard, Biloxi, Miss., July 1, 1895, no. 1417.

Drummond, New Orleans, 1832.

Curtiss' plant, and also my own, both cited above, well represent the late and much branched state, while Simpson's no. 298, and the plant collected by Ravenal, both also alluded to above, present the state of the plant in its early and simple condition.

This is closely related to *P. angustifolium* Ell., a specimen of which, so named by Elliott, is in the herbarium of Columbia University. The smaller obtuse spikelets which are broader in proportion to their length and the branches of the primary panicle remaining contracted for some time readily separate it from the *P. angustifolium* Ell., in which the spikelets are acute and considerably larger, and the primary panicle branches not remaining contracted, but spreading at once.

As this grass is apparently quite common, there may be an older name than the above, but up to the present search has failed to reveal it. When a proper disposition is made of the species of Elliott and Michaux, and some of the other early southern botanists, some name among them may be found to apply to this plant. There can be no doubt, however, as to this grass being the *P. neuranthum* of Grisebach, for, as stated above, it exactly matches the form upon which he based the species.

PANICUM ANGUSTIFOLIUM Ell. Bot. S. C. & Ga. 1: 129. 1817.

P. neuranthum var. *ramosum* Griseb. Cat. Pl. Cub. 232. 1866.

As stated above, this appears to be clearly distinct from *P. neuranthum* Grisebach. The specimen on which Grisebach based his variety *ramosum*, no. 3454 of Wright's Cuban Collection, matches the late and much branched condition of Elliott's *P. angustifolium*, well represented by Curtiss' nos. 4028 and 4678. In addition to those cited already, I would refer the following to this species:

Vasey, Norfolk, Va., in pine woods, 1884.

Ravenal, Aiken, S. C., June 1, 1867.

M. A. Curtiss, N. C.

A. H. Curtiss, Florida, Duval Co., no. 3583*; Jacksonville, nos. 4028 and 4678.

Nash, Eustis, Florida, 1894, nos. 319, 560, 598, 926, 1226, 1425 and 1436; 1895, no. 1856.

S. M. Tracy, Mississippi, Crystal Springs, no. 117; Biloxi, no. 3091.

Langlois, Louisiana, October 1, 1890.

PANICUM POLYCAULON n. sp.

Plant yellowish green, with the habit of *P. ciliatum* Ell., smooth and glabrous, excepting the margins of the sheaths and leaves, and the axis of the panicle which is sparingly pilose. Culms densely caespitose, the upper portion naked, 2 dm. tall or less, erect, simple, or at length somewhat branched; sheaths coarsely striate, ciliate on their margins, the lower loose, 2.5 cm. long or less, the uppermost one longer than the remainder; ligule a ring of very short hairs; leaves erect or ascending, narrowly oblong-lanceolate, 2–7 cm. long, 2–8 mm. wide, somewhat narrowed toward the rounded base, acuminate at the apex, ciliate on the margins with somewhat ascending hairs, 7–9-nerved, the mid-nerve prominent; panicle broadly ovate, 3 cm. long or less, its branches spreading or ascending, their ultimate divisions several times longer than the spikelets, the main axis and usually the lower branches sparingly pilose; spikelets about 1.5 mm. long, divergent from the branches of the panicle, obovate, obtuse, the first scale about one-half as long as the spikelet, thin membranous, orbicular-ovate, obtuse, 1-nerved, the second and third scales equal in length, membranous, broadly oval, 7-nerved, the latter enclosing a hyaline palet about one-half its length, the fourth scale chartaceous, oval, white, enclosing a palet of equal length and similar texture.

Type specimen collected by the writer on Aug. 20, 1895, in the "flatwoods" at Tampa, Florida, no. 2420a. A specimen in the Columbia University herbarium collected by Chapman belongs here; no. 3875 of Wright's Cuban Collection of 1865, distributed as *P. dichotomum* L., is also to be referred to this species.

The narrower leaves, more slender culms, and smaller and glabrous spikelets well distinguish this from *P. ciliatum* Ell., to which it is most nearly allied.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 118.

Gyrothyra, a new Genus of Hepaticae

BY MARSHALL A. HOWE.

(PLATES 302, 303.)

[Reprinted from THE BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 24, No. 4, April 24, 1897.]

Gyrothyra, a new Genus of Hepaticae.

By Marshall A. Howe.

(Plates 302, 303.)

GYROTHYRA.

Stem creeping, foliose, subsimple or somewhat sparingly branching, radiculose. Leaves succubous, entire, alternate; underleaves present, free, bifid, segments narrowly lanceolate or subulate; walls of the leaf-cells with triangular thickenings at the angles. Antheridia short-stalked, in the axils of smaller saccate leaves, forming short median or, at first, terminal spikes. Involucral leaves 2–4 pairs (commonly 3 pairs). Perianth terminal, confluent for half its length or more with the bases of the involucral leaves, the greater part of the calyptra, and the tissues of the stem, to form a thick-walled tube (perigynium), with a small bulbous or saccate base; perigynium erect or ascending, making, at maturity, nearly a right angle with the stem. Capsule cylindrical, long-exserted, dehiscing spirally by four very long and slender valves; capsule-valves of two layers of cells, whose walls are wholly destitute of spiral, semiannular, or other local thickenings. Elaters free, bispiral, acute or bluntly pointed; spores minutely papillate. "Involucellum" of the sporogonium foot well developed. (Name from γυρὸς, twisted, and θύρα, door.)

GYROTHYRA UNDERWOODIANA.

Dioicous. Plants rather large, 1–2 cm. long, 2–4 mm. wide, mostly in compact light green tufts; stems creeping, thick, often slightly flattened dorso-ventrally, .5–.65 mm. in diameter, about 15 cells wide in cross section, very densely radiculose, slightly ascending at apex, subsimple or with a few irregularly disposed lateral branches, in female plant innovating from near base of perigynium; root-hairs long, nearly colorless or of a dilute yellowish-brown hue, sometimes tinged proximally with purple, springing in older parts of the stem from oblong or linear dark-purple callosities, made up of the closely coherent root-hair bases and of other ventrally elongated cells; leaves obliquely inserted, lingulate or oval, succubous, rather close, translucent, alternate, scarcely decurrent dorsally, often crowded and suberect at stem apex, marginate, commonly concave below, apex decurved, 1.4–2 mm. × 1.7–4 mm.; cells of the margin quadrate or oblong, equalling in size the adjacent or twice as large; other leaf-cells mostly quite regularly pentagonal or hexagonal, 25–70 μ in diameter, oblong and larger towards the base; all with conspicuous trigones; under-leaves free, often wine-colored, .6–1 mm. long, bifid ½–⅔ the length into narrowly lanceolate or subulate segments, usually running out into a single series of cells at apex, concealed by the dense mat of root-hairs, except in the younger portions of the stem; perigynium tubular, 1–1½ mm. in diameter, and, with the free portion of the perianth, 3–4 mm. long, erect or ascending, nearly at right angles with the stem, tinged with purple ventrally, bulbous or saccate at base; wall of perigynium-tube 5–20 cells in thickness; involucral leaves 2–4 pairs (commonly 3 pairs), entire or repand, similar in form to the cauline, margins approximate at base dorsally, distant ventrally; uppermost pair inserted at about middle of perianth-tube or, more rarely, at two-thirds its height, erect, apex and dorsal margins narrowly reflexed and exposing the perianth, or closely appressed and wholly concealing it; next lower pair usually inserted at about one-third height of perianth-tube, more broadly reflexed; the one or two basal pairs but slightly attached to perigynium; involucral underleaves inconspicuous, sometimes subentire and slightly adherent to base of involucral leaves; bulbus of perigynium without radicles, but a dense tuft of root-hairs springs from the stem just back of the bulbus and long root-hairs come from the cells of the involucral leaves near their bases; perianth free for ⅓–½ its length, free portion nearly echlorophyllose, subtubular, somewhat inflated below, contracted and lax above, crenulate at mouth, 3–5 cells thick at juncture with perigynium-tube, 2 cells thick at mouth; calyptra fleshy, upper third or fourth free at maturity, 3–6 cells in thickness; archegonia several, the unfertilized raised on the base of the free portion of calyptra.

Capsule long-cylindrical; valves very slender, 3.3–6 mm. × .13–.17 mm., widely spreading when dry, attached spiro-radially to a basal disc composed of large hyaline cells, flexuous, contorted, or spiral, on moistening,—always with a spiral twist at the apex; foot of sporogonium forming a more or less goblet-shaped "involucellum"; seta 1½–2 cm. long; elaters bi-spiral, very rarely tri-spiral, acute or sub-obtuse, 210–420 × 12–15 μ; spores about 12 μ, minutely papillate.

Male plants more slender; antheridia (1–6) in the axils of smaller saccate leaves, forming spikes of 3–6 pairs of leaves decreasing in size upwards, appressed, apices patent or recurved, or, in uppermost pair, erect; antheridia ellipsoidal or pyriform, .15 × .24 mm., on pedicels ⅓ as long; slender stems (male?) occasionally gemmiferous at apex, gemmae unicellular, 10–24 μ in diameter.

Collected by the author on clay banks near Eureka, Humboldt Co., California, June, 1896; also by Prof. John Macoun (Herb. Underwood), on earth in a brook, Burrard Inlet, British Columbia, April 6, 1889, and on rocks, British Columbia, April 29, 1889.

The leaves of the British Columbia plants stand with their margins more often erect than in the California specimens, upon which our description and figures have been based. In the sterile condition, *Gyrothyra* somewhat resembles the larger forms of *Nardia scalaris*—also collected by Macoun on Vancouver Island (Can. Hep. 80)—but can readily be distinguished by the margined, lingulate, more translucent leaves and by the bifid underleaves.

The involucral leaves, though more or less apparently paired, are in a strict sense alternate like the cauline, and a single unpaired leaf is sometimes found to occur inside the pair we have described as the uppermost.

It should be remarked that but few capsules of the plant have been seen and that these were already open or so young as to be still enclosed within the calyptra, so the actual dehiscence has not been observed, but the extremely long valves, which on being soaked out take easily a position strongly suggestive of the paring of an apple, the spiro-radial attachment to the basal disc, the never failing spiral twist of the valve-apex, and the spiral lines readily discernible on the surface of the embryo capsule (fig. 10) make, in the judgment of the writer, the induction that the dehiscence is spiral so safe and certain that he has felt no hesitation in so describing it and in basing the generic name upon this character. The absence of thickenings in the walls of the cells of the capsule valves is noteworthy. Schiffner states* of all the *Jungermaniaceae akrogynae:* "Die reife Kapsel besitzt eine aus 2 bis mehr Zellschichten bestehende Wand, deren Innenschicht in ihren Zellen stets Verdickungsleisten enthält." In *Gyrothyra*, the transverse walls of these cells usually appear a trifle thicker than the longitudinal, but the walls are otherwise wholly without traces of local thickening.

In respect to structure of the sporogonial envelopes, *Gyrothyra* is one of several very interesting transitions from the ordinary Jungermania type to the various pouch-bearing genera. Considered from this point of view and from certain other gametophytic characters, its nearest affinities are undoubtedly to be found in that section of *Nardia* represented by *Nardia haematosticta* (Nees) Lindb., of Europe. In manner of dehiscence of capsule it recalls the marsupiiferous genus *Kantia;* but the valves of *Gyrothyra* are much longer and their cell-walls lack the local thickening, while, of course, no generic comparison of the two can be made so far as the gametophyte is concerned.

It is with pleasure that the author associates with this novel plant the name of one who, by his numerous papers upon the American Hepaticae, as well as by his unfailing generosity, has placed the younger workers in the same field under lasting obligations. It should be noted that, although Professor Macoun's specimens were without the capsules, which reveal the distinctive generic character of *Gyrothyra*, Professor Underwood had already recognized that they represented something undescribed.

Explanation of Plates 302, 303.

1. Entire ♀ plant. × 5.
2. Cauline leaves. × 18.
3. Marginal and adjacent leaf-cells. × 225.
4. Transverse section through marginal portion of leaf. × 216.
5. Underleaves. × 24.

* Engler and Prantl, Nat. Pfl. Fam. 1: Abt. 3, 71.

6. Transverse sections of stem $\times$ 22, showing ventral callosity from which the root-hairs arise.

7. Antheridium. $\times$ 40.

8. Median sagittal section of perigynium and adjacent portions of stem, showing embryo sporogonium with capsule, seta, foot, and "involucellum," also unfertilized archegonia, perianth, insertion of involucral leaves, root-hair callosity, etc. $\times$ 23 (slightly schematized). The free part of the perianth as drawn here and in the next is proportionally rather too short and not sufficiently inflated below.

9. Sagittal section of mature perigynium from which the seta has been detached, showing fully developed calyptra and the unfertilized archegonia raised upon the base of its free portion, $\times$ 20 (slightly schematized).

10. Surface view of embryo capsule, exhibiting the spiral lines, which presumably bound the valves. $\times$ 50.

11. Valves of capsules, showing position taken by them when moistened. $\times$ 12.

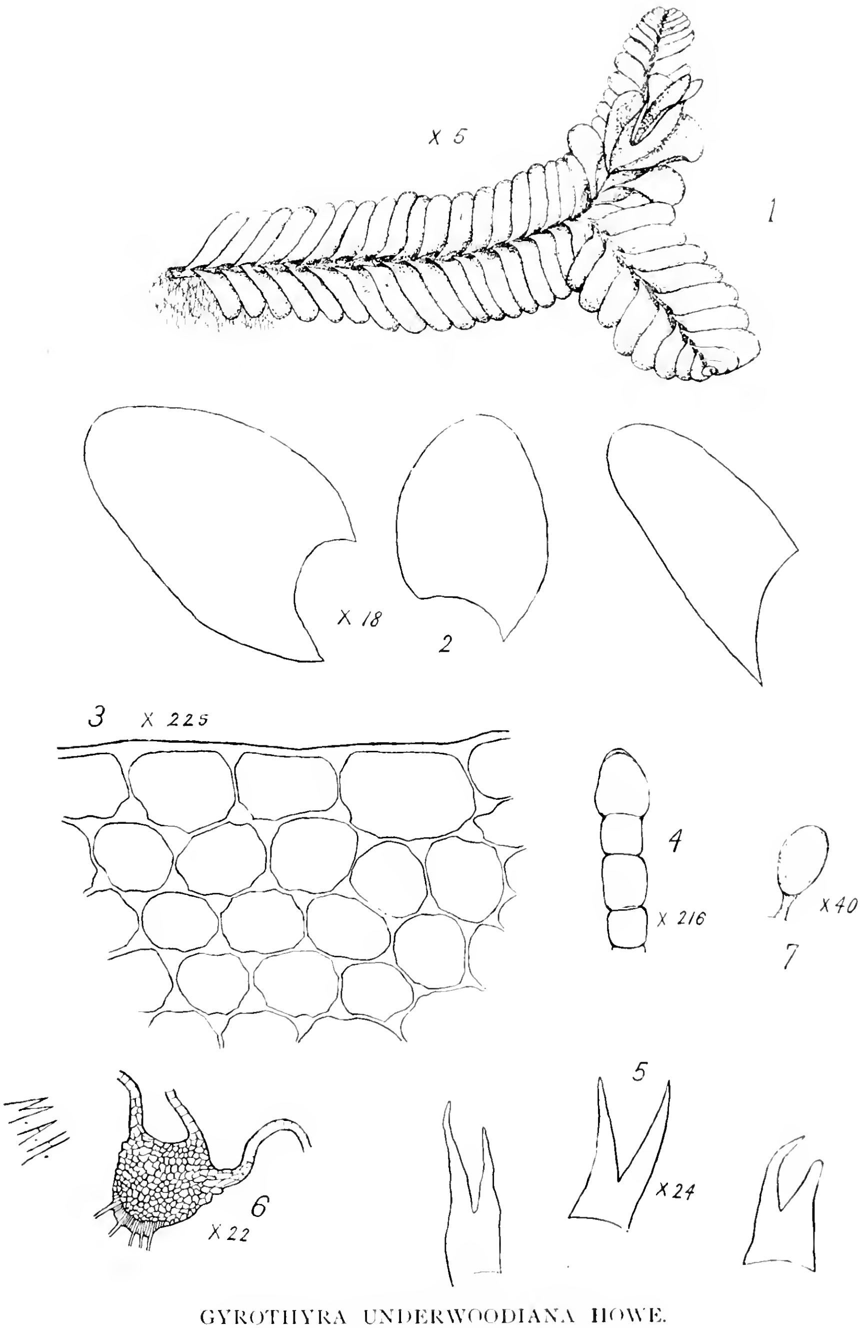
12. Apex of a single valve. $\times$ 12.

13. Base of dehisced capsule from above, showing spiro-radial insertion of valves. $\times$ 36.

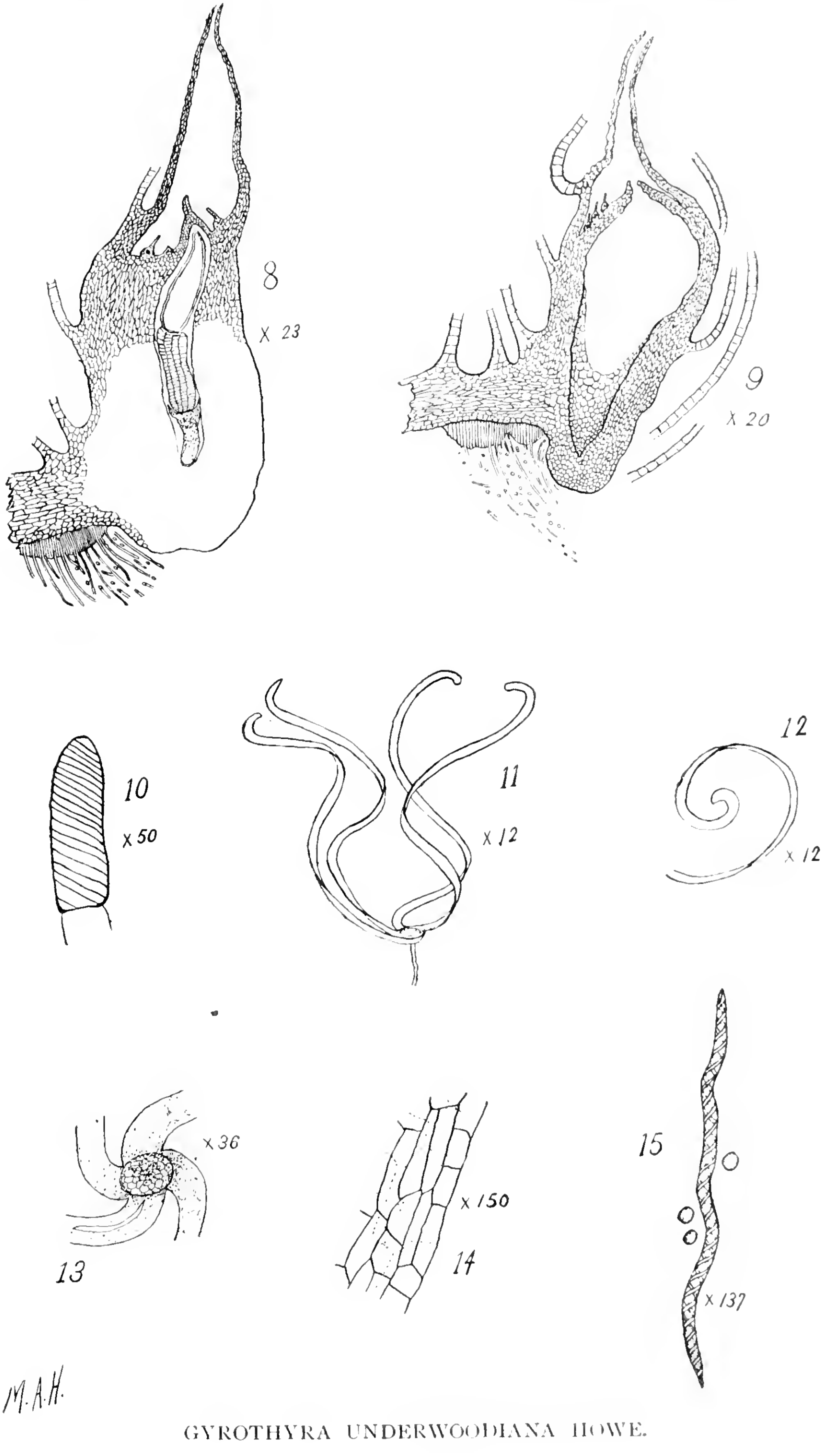
14. Cells of inner surface of capsule valve. $\times$ 150.

15. Elater and spores. $\times$ 137.

Columbia University, Department of Botany,
April 9, 1897.



GYROTHYRA UNDERWOODIANA HOWE.



GYROTHYRA UNDERWOODIANA HOWE.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 119.

THE NATURE AND ORIGIN OF STIPULES.

BY A. A. TYLER.

NEW YORK:
1897.

[Reprinted from the ANNALS OF THE NEW YORK ACADEMY OF SCIENCES, Vol. X.]

ANNALS

OF THE

NEW YORK ACADEMY OF SCIENCES,

VOLUME X.

I.—*The Nature and Origin of Stipules.*

BY A. A. TYLER, A.M.

Read Feb. 8, 1897.

The investigation which has resulted in the preparation of this dissertation was undertaken with a view to determine the true nature and phylogenetic origin of those appendages of the bases of the petioles of leaves which are known as stipules and which are present in so large a number of the families of flowering plants.

The data have been collected from every available source; the evidences to be gathered from known geological facts have been taken into consideration, observations have been made upon the morphology and anatomy of the foliar organs in a large number of cases, and the gradual modification of leaf-forms in the annual growth of plants from simple scales to adult leaves has been carefully studied. In addition to the data so gathered, the literature dealing with the subject, relatively scanty though it is, has yielded much valuable material both by the record given of the observations of others and by the suggestion of lines of investigation.

With all this material in hand, I have endeavored to ground the theoretical consideration of the problem upon the broadest foundation possible in the present stage of the progress of science, and from a comparative study of the evidence gathered from all the various sources of information, have drawn the conclusions set forth at the close of my paper.

The results of my investigations are herewith given to the public with the conviction that conclusions arrived at in the manner indicated cannot fail of interest to the reader, nor, in some degree at least, of scientific value.

COLUMBIA UNIVERSITY,
NEW YORK. Feb. 8. 1897.

SYNOPSIS.

A Review of Important Literature Pertaining to Stipules.

Owing to the fact that a large part of the literature pertaining to stipules is inaccessible to the majority of botanical students, scattered as it is, for the most part, in the journals of various scientific bodies, it has seemed desirable to preface the consideration of the results of my research on the question of the Nature and Origin of Stipules with a brief summary, in chronological order, of the publications having reference to the general subject of stipules. I have, however, omitted mention of their consideration in systematic works and the general allusions and definitions as they occur in most general works on the Spermatophyta together with their special consideration in individual species and groups except in the most important cases.

Stipules have not received a very large degree of attention from botanists apart from their morphology as used in classification and the publications to be considered are not very numerous, but it is thought that a review of those following will be profitable and of general interest:

Malpighi, Marcello.—Opera omnia, 22–39. 1686.

This is one of the earliest works in which stipules are treated. A considerable number are figured and described under the name of *foliola caduca.*

Linnæus, Carolus.—Philosophica Botanica, 50. 1751.

A general definition is given of stipules as scales borne at the base of the petiole. Buds are spoken of as formed by stipules, by petioles, or by rudiments of leaves.

Linnæus, Carolus.—Prælectiones in ordines naturales plantarum, 520. 1792. (Cited by Hanstein in Abhandl. Akad. Berlin, 77. 1857.)

In speaking of the whorled leaves of the Stellatæ, Linnæus says that only two of these leaves are true leaves, the remainder are stipules which have grown to the same size as the leaves.

De Candolle, Augustin P.—Theorie de la Botanique, 364. 1819.

The stipule is defined as a foliaceous appendage or accessory leaf situated at the base of certain leaves. The stipel, first so named by De Candolle, is defined as a stipule placed on the common petiole at the base of the leaflets.

De Candolle, Augustin P.—Organographie Végétale, 1 ; 334–341. 1827.

De Candolle's views as here expressed may be outlined as follows: "Stipules do not exist in any monocotyledonous plant,* nor in any dicotyledons in which the petiole has a sheathing base; among dicotyledons with leaves not sheathing, stipules are frequently wanting, especially in plants with opposite leaves. Their existence is intimately connected with the general symmetry of plants, and they occur or are wanting in all the species of a family.

"The only essential character of stipules is their lateral position at the base of the leaves, and it is not impossible that we confound under a common name objects really distinct. Their texture is, in many plants, perfectly foliaceous and in these cases they exhibit so exactly the character of leaves that we can say that they are small accessory leaves.

"In certain verticillate leaves, such as those of *Galium*, it is noticeable that the buds and young branches are not produced in the axils of all the leaves, but only of two among them which are opposite to one another. I presume that these two leaves furnished with buds are the true leaves and that the others should be considered as foliaceous stipules.

"The natural use of stipules seems to be the protection of the leaves during their development, but we must admit that in many cases their smallness or their nature or form make them inappropriate to this use, though we cannot well assign another to them, those which are foliaceous assist in the elaboration of the sap, those which are changed into spines serve for the defense of the plant.

"The tendril in the Cucurbitaceæ is perhaps a modified stipule. The ochrea of Polygonums is a prolongation of the base of the petiole into connate stipules."

In volume 2, pages 213 and 214, De Candolle says in treating of buds, "They have received particular names according as they are formed by different parts of the foliar organs, and according to the degree of their degeneration and adnation.

"1. Buds are called foliar when, the leaves being sessile, the blade itself, reduced to the form of a scale, forms the buds, as in *Daphne mezereum* L.

"2. They are called petiolar when the bases of the petioles dila-

* See also A. Richard. Précis de Bot., 126.

ted into scales form the covering of the young shoot. This occurs in petiolate leaves without stipules, as in the walnut, ash and horse-chestnut.

"3. Buds are stipular when the scales are formed, not by the leaves, but by the stipules which are not united with the petioles. Of these there are two sorts,—those which are formed by a great number of stipules enclosing a young shoot collectively, as in oaks, willows and elms, and those in which the stipules, free or united by their exterior margins, form a peculiar envelope for each leaf, as in *Ficus* and the magnolias.

"4. When the stipules are adherent with the petiole, these two organs united into one form the bud scales, and are named fulcral. This occurs in most of the Rosaceæ, and the scales are frequently three-lobed or three-toothed, indicating the origin of the scale formed by the petiole and the two stipules united together." Plate 21, figure 9, shows the progressive change from scales to foliage-leaves in buds that are fulcral in nature.

Bischoff, G. W.—Lehrbuch der Botanik. 177–183. 1834.

The subject is here more fully outlined than in De Candolle's Organographie. Stipules are defined as peculiar leafy expansions at the base of a free middle leaf. They are recognized as belonging to the leaf on the ground of their frequent connection with the petiole, the receiving of their vascular bundles from those of the leaf and the absence of buds from their axils. Various kinds of stipules are described and the ochrea, the ligule, the stipule in the Naiadaceæ and the ochrea of palms are included with stipular formations.

Lindley, John.—Introduction to Botany, 99. 1832.

The following statement is of interest: "The exact analogy of stipules is not well made out. I am clearly of opinion that, notwithstanding the difference in their appearance, they are really accessory leaves; because they are occasionally transformed into leaves, as in *Rosa bracteata*, because they are often indistinguishable from leaves of which they obviously perform all the functions, as in *Lathyrus*, and because there are cases in which buds develop in their axilla, as in *Salix*, a property peculiar to leaves and their modifications." The character of stipules is denied to the tendril of the Cucurbitaceæ and the tendrils of *Smilax* (p. 96) are regarded as lateral branches of the petiole.

Henry, A.—Recherches sur les bourgeons. Nova Acta Acad. Nat. 18 : 525–540. 1836. (Cited by Clos in Bull. Soc. Bot. Fr. 26 : 193. 1879.)

Henry says that he recognizes in the Betulaceæ and Cupuliferæ that the bud-scales are formed by stipules in an anamorphosed condition, and that in *Platanus* they are formed by the ochrea as he terms the basal foliar appendage in this genus.

Lestiboudois, Them.—Etudes sur l'anatomie et la physiologie des vegetaux. 1840. (Cited by himself in Bull. Soc. Bot. Fr. 4 : 746–747. 1857.)

The author states that he has shown that stipules are parts of the leaf, formed by the bundles or lateral fibers of these organs, whether they arise from bundles not yet having left the stem, from anastomosing arcades which unite the leaves as in the Stellatæ, or from the fibres of the petiole, as in the adnate stipules of Rosaceæ, or whether they are in part supplied by bundles directly from the cauline cylinder, as in *Platanus.*

In relation to the tendril in the Cucurbitaceae, he states that its bundles are derived from those which pertain to the axillary bud; that it is therefore not a stipule, but the first foliar appendage of the axillary branch for its fibro-vascular bundles are not disposed like those of stems, but are analogous with those of petioles.

St. Hilaire, Aug.—Leçons de Botanique. 170, 1840. (Quoted by Colomb in Ann. Sci. Nat. (VII), 6 : 28. 1887.)

It is stated that the tendrils of *Smilax* are to be considered as lateral leaflets of a compound leaf.

Agardh, J. G.—Ueber die Nebenblätter der Pflanzen. (Reviewed by Fries and Wahlberg in Flora, 33 : 758–761. 1850.)

Agardh believes that, although stipules have been considered as degenerate appendages of the leaf or modifications of it, they are not at all a part of the leaf because they are formed before it, and must be considered as independent organs. The outer bud-scales and also the protective coverings of the earliest shoots of a plant are a kind of stipule-formation, leading to the conclusion that in the lower part of a shoot or the outer part of a bud the stipule-formation preponderates, and in the upper or inner parts, the leaf-formation, so that often at the lowest nodes the leaf does not develop and at the upper stipules are absent. In *Tussilago* there are special leafy shoots and the flowering shoots are provided with stipules only.

From these considerations Agardh concludes that there are two kinds of appendicular organs instead of one, namely stipules and leaves.

Astaix.—Essai sur la Théorie des stipules, thése de l'Ecole de pharmacie de Paris. 1–25. 1841. (Cited by Clos in Bull. Soc. Bot. Fr. 1: 302. 1851.)

The conclusion is reached that the leaf is not a primitive appendage of the stipule and that the stipule is nothing more than an appendage of the leaf.

Regel, E.—Beobachtung über den Ursprung und Zweck der Stipeln. Linnæa, 17: 193–234. 1843.

Regel has studied the development of stipules in seedlings and in the growth of individual leaves. He believes, but does not feel ready to assert, that stipules are present in all Angiosperms in the earliest stages of growth. He therefore includes in stipular formations the ligule, ochrea, sheathing petiole and the supernumerary leaves of the Stellatæ. He concludes from his observations:

1. "That all the leafy organs of phanerogamic plants are divided into two entirely distinct formations, the stipular and leaf-formations.

2. "That the stipular formation arises from the base of the meristem tissue of the leafy axis, covering the summit, but always with a longitudinal cleft or one passing transversely across the apex.

3. "That perfect stipules are formed by the occurrence of two, four or more clefts in the original stipular sheath, giving rise to as many stipular leaflets.

4. "That the stipules receive their vascular bundles directly from the stem, and are usually parallel veined because of their forming originally a completely encircling sheath.

5. "That they serve always for the protection of the growing point and of the true leaves, when these are present, during their development.

6. "In all plants, organs adapted for protection belong not to the leaf-formation but to the stipule-formation.

7. "That stipules are to be regarded as a formation preceding the leaf-formation, since they appear before the leaves.

8. "That they belong primarily to a nodal ring distinct from that producing the leaves and situated either above or below it.

From these relations, as regards the leaf, interior and exterior stipules are distinguished.

9. "Interior stipules protect the formation of the following node and leaves. The leaf at the same node develops somewhat earlier or at about the same time.

10. "Exterior stipules develop before the leaf at the same node and therefore protect their own node with its leaf.

11. "As stipules are limited in the time during which they are functional, they lose their significance as soon as this purpose is fulfilled. They do not produce buds in their axils except in cases where true leaves are not developed."

The following statement (p. 227) should be noted. "In some species of *Thalictrum* the membrane rising above the inner margin of the base of the petiole is the analogue of the ligule."

Kirschleger, F.—Flora, 28 : 615. 1845.

The tendril of Cucurbitaceæ is regarded as a normal stipular formation.

Mercklin, C. E.—Entwicklungsgeschicte der Blattgestalten. 1846. (Translated into the French in Ann. Sci. Nat. (III), 6 : 215–246. 1846.)

The statements of Mercklin are contrary to those of Regel. He says, "In all cases the stipules of the developing leaf appear as portions of the lamina; it is only later, during the development and elongation of the petiole, that they become sufficiently separated to be considered as distinct organs. In all simple leaves the stipules never appear at the same time with the first rudiments of the lamina; they develop only with the inferior parts of the lamina including the petiole."

"From my observations of stipules I conclude that in common with the leaflets they owe their origin to the common petiole and are formed later than the leaflets."

Krause, G.—Einige Bemerke über den Blumenbau der Fumariaceæ und Cruciferæ. B. Cruciferæ. Bot. Zeit. 4 : 137–150. 1846.

Stipules in the Cruciferæ are considered (pp. 142–145) and the homology with stipules of the so-called glands at the base of the leaves is established by a careful series of observations upon their development. The glands of the bracts and floral organs are also included.*

* See also Duchartre, Rev. Bot. 2 : 208. 1845–7 and Norman, Quelques Observ. de Morph. Veg. 1857.

Jussieu, Adrien.—Cours d'Histoire Naturelle: Botanique. 108–111. 1852.

Speaking of the leaf-sheath, Jussieu says that "sometimes the vascular bundles converge little by little, and there is a gradual transition from the sheath to the petiole; sometimes the marginal bundles stop after a course varying in length, or are prolonged in another plane than that of the petiole, and then there is a clear distinction of petiole and sheath. Often, however, the parenchyma does not unite the lateral bundles to the central ones which continue in the petiole, and this is the probable origin of many stipules."

Trécul, A.—Sur la Formation des Feuilles. Ann. Sci. Nat. (III), 20: 288–299. 1853.

The usual classification of stipules is given with the addition of extra-foliar stipules to include those of *Nelumbium*. The author says, "In all adnate stipules that I have seen, they do not envelop the leaf to which they belong, but that which comes next after them, and their own leaf is protected by the stipules of the leaf preceding. Under these circumstances the stipules play the same rôle as the sheath, from which they differ very little. We see thus clearly that there is the closest analogy between the formation of adnate stipules and that of a sheath; the analogy is such that it is impossible to distinguish between them in principle." All the forms of stipules, the ochrea, the tendrils of *Smilax* and the ligule of grasses are classed together.

Among the conclusions those relating to stipules are as follows: In basifugal leaf-formation all the parts are formed from below upward, the stipules first of all. In leaves with basipetal formation, the stipules have their origin earlier than the lower parts of the blade and sometimes even before the upper.

Trécul, A.—Vegetation du Nelumbium codophyllum. Ann. Sci. Nat. (IV), 1: 291–298. 1854.

In the seedling of this plant the leaves are in two ranks on the upper and lower sides of the rhizome and each of them is provided with an axillary stipule. In its later stages the leaves of the lower rank are aborted with the exception of the stipule of every second one and in the upper rank every second leaf is represented by the stipule only. The internodes above the stipules which stand alone remain undeveloped so that three stipules are associated with each leaf, one axillary and two extra-axillary.

One of these last is on the upper side of the rhizome external to the leaf, the other on the lower side.

This paper was presented before the Botanical Society of France, May 24, 1854. M. Ad. Brongniart took part in the discussion which followed. He agreed with Trécul in his conclusions and closed with the statement that "this arrangement recalls that of certain buds in which the scales result from the stipules of leaves of which the petiole and blade are alike aborted." M. F. J. Lestiboudois remarked that "to decide whether stipules are an integral part of the leaf, it is necessary to study them anatomically. In other plants the same fibro-vascular bundles are distributed to the leaf and stipules. Stipules should therefore be regarded as appendages of the leaf."

Clos, D.—Considerations sur la Nature du prétendu Calicule ou involucre des Malvacées. Bull. Soc. Bot. Fr. 1: 289–303. 1854.

The stipular nature of the parts of the involucre or exterior calyx in the Malvaceæ is asserted contrary to the views of Aug. St. Hilaire (Leçons de Bot. 372. 1840) and the term *stipulium* is suggested as applicable to it.

Clos, D.—Du Stipulium chez les Géraniacées, les Légumeneuses et les Rosacées. Bull. Soc. Bot. Fr. 2: 4. 1855.

The term *stipulium* is applied to the exterior calyx of the Malvaceæ and the involucre of the umbel of some Geraniaceæ. In the Cistaceæ the bractlets of the calyx are wanting in exstipulate species.* In many of the Leguminosæ and Rosaceæ the bracts are evidently formed by stipules.

Clos, D.—La Vrille des Cucurbitacées, Organe de Dédoublement de la Feuille. Bull. Soc. Bot. Fr. 3: 545–548. 1856.

The different theories regarding the tendril in the Cucurbitaceæ are briefly stated. They have been considered to be roots; abortive peduncles by Tassi; stipules by De Candolle, Stoks and Aug. St. Hilaire; leaves by Gasparini, Seringe and Braun; degenerate branches by Meneghini; superfluous branches by Link; terminal branches of the axis as in Vitaceæ by Fabre; partly leaf, partly branch by Naudin. Clos concludes that the tendril arises by a division of the leaf, three fibrovascular bundles entering the leaf when there is no tendril and two when the tendril is present and receives the third bundle.

*See also Aug. St. Hilaire. Leçons de Bot. 326 and 371. 1840.

Clos, D.—Les Vrilles des Smilax ni Folioles ni Stipules. Bull. Soc. Bot. Fr. 4: 984–987. 1857.

A summary is given of the literature pertaining to the tendrils of *Smilax*. They are considered as representing two lateral leaflets of a compound leaf by von Mohl (Ueber den Bau und das Winden der Ranken und Schlingpflanzen, 41, 1827), Lindley (Introd. to Botany, Ed. 2, 118, 1835), Link (Elem. Phil. Bot. Ed. 2, 1 : 478, 1837), St. Hilaire (Leçons de Bot. 170 and 854, 1840), Le Maout (Atlas de Bot. 23, 1846) and Duchartre (Art. vrille in Dict. Univ. Hist. Nat.).

Mirbel (Élém. de Physiol. et de Bot., 2: 680, 1815), Treviranus (Physiol. der Gewachse. 2: 138, 1838), Seringe (Élém. de Bot. 175, 1841), De Candolle (Theorie Élément. Ed. 3, 321, 1844), Trècul (Ann. Sci. Nat. (III), 20: 295, 1854) and Lestiboudois (Bull. Soc. Bot. Fr. 4: 745, 1857), believe these organs to be stipular tendrils. It is the opinion of Clos that they are neither leaflets nor stipules, but a double lateral prolongation of the cellulo-vascular elements of the petiole.

Rossman, J.—Beiträge zur Kentniss der Phyllomorphose. 1857. (Cited by Clos in Bull. Soc. Bot. Fr. 26: 192. 1879.)

Rossman considers the problem of the nature of stipules, and from a study of bud-scales arrived at his conclusions. He figures the passage from bud-scales to leaves in *Ribes sanguineum* Pursh, *Prunus Padus* L., *Spiræa sorbifolia* L., etc. He notes the presence in the bud-scales of three median veins, separated at the base and joining one another at the apex, where the petiole will originate. The lateral parts of the scale outside of these three nerves he believes to represent the stipules which show themselves at the appearance of the blade in two little points at the apex.

Hanstein, J.—Ueber gürtleformige Gefässstrang-Verbindung in Stengleknoten dicotyler Gewächse. Abhandl. der Akademie der Wissenschaften zu Berlin, 1857 : 77–98. 1858.

The vascular nodal girdle of the Stellatæ is treated of at length. It is shown that from this girdle arise the bundles that supply those leaves of the whorl which are really stipules, and in some cases also the veins of the lateral parts of the true leaves. Similar nodal girdles are shown to exist in other families of plants, notably in *Sambucus*, *Valeriana*, *Verbena*, *Dipsacus*, *Scabiosa*, *Dahlia* and *Silphium*. In *Sambucus Ebulus* L. the girdle sends off vascular branches to true stipules. In the majority of other cases if branches arise they enter the margins of the petioles or the interfoliar portions of connate leaves. In *Platanus* and *Liriodendron* with alternate leaves, each of which receives seven vascular bundles, a similar girdle is shown to pass around the stem posterior to the leaf, and is there joined by another small leaf-trace bundle. From this girdle arise a part of the stipular veins, the others being branches of the sixth and seventh leaf-trace bundles.

Clos, D.—Sépales Stipulaires. Bull. Soc. Bot. Fr. 6: 580–589. 1859.

It is argued from the similarity of the sepals to the divisions of the involucre (stipulium) and also to the stipules of the fully developed foliage leaves which is frequently observed, that they represent stipules. This is held to be true in many Geraniaceæ, Malvaceæ, Begoniaceæ and Cistaceæ. In concluding Clos adds the theoretical consideration that "whether or not stipules are admitted to be organs different from the leaf, analogy seems to demand that in some cases at least they should participate in some degree in floral formation."

Cosson, E.—Note sur la Stipule et la Préfeuille dans le Genre Potamogeton. Bull. Soc. Bot. Fr. 7: 715–720. 1860.

"The stipule in *Potamogeton* is very closely like the first leaf of one of the branches. It is homologous with the ligule of the Gramineæ and Cyperaceæ and is constituted by a single organ, not by two united by their margins."

Eichler, A. W.—Zur Entwicklungsgeschichte des Blattes. 22–31, 1861 (Cited by Martin Franke in Bot. Zeit. 54 : 45, 1896.)

Stipules are said to arise without exception as a product of the leaf base of the primordial leaf. This mode of origin of the stipules is their chief characteristic. Their form, their more or less foliaceous condition and their persistence are secondary.

In individual leaf development in the Stellatæ, the whorl originates in a uniform ring about the growing point. Then arise two opposite prominences in the ring. These develop into the true leaves. After them appear two smaller prominences on each side of the stem between the first. These are the stipules. According to the species they develop separately, forming six-leaved whorls, or grow together giving origin to four-leaved whorls.*

*With this view Göbel agrees (Schenk's Handbuch der Botanik 3 : 230. 1884), except that he does not distinguish the time of appearance of the different parts of the whorl.

Where a larger number of leaves occurs, an additional prominence for each arises between the original stipular prominences.*

Cauvet, D.—Probabilité de la Presence des Stipules dans quelques Monocotyedones. Bull. Soc. Bot. Fr. 12 : 241. 1865.

A number of cases are considered and the conclusion drawn that very probably some Monocotyledones are provided with stipules, but the difference in their form and position has caused them to be considered as another kind of organ.

Meehan, Thomas.—On the Stipules of Magnolia and Liriodendron. Proc. Acad. Nat. Sci. Phila. 114–116. 1870.

Mr. Meehan argues for the origin of the stipules of *Magnolia* as lobes of the lamina similar to the auricles which occur in *M. Fraseri* Walt. by a union of the auricles with the upper surface of the petiole, and a subsequent adnation of their margins and separation from the lamina. He says, "It is scarcely possible to avoid the suspicion that the stipules of *Magnolia* are not formed like the stipules of most plants which are perhaps leaf portions which have never been well developed, but rather are the tolerably well developed side pinnules of a trifoliate or deeply auricled leaf."

Speaking of observations upon the flowers of *M. fuscata* Andr., of East India, the following interesting statement is made: "This observation confirms the views of some botanists as I have learned from Professor Asa Gray, that it is by metamorphosis of the petiolar and stipular parts, rather than by modifications of the leaf-blade, that petals are formed."

Duval-Jouve, J.—Sur quelques tissues de Joncées, etc. Bull. Soc. Bot. Fr. 18 : 231–239. 1871.

The presence of the ligule in the Juncaceæ is treated of. To quote the author, "If in certain species the ligule is so reduced that it appears to be lacking between the separated auricles at the apex of the sheath, in most others these auricles are united by a true ligule, as pronounced as that of grasses, either entire or cleft at the middle."

Dutaily, G.—Sur les variations de structure de la ligule des Graminées. Bull. de la Soc. Linnéene, 170. 1878.

*F. Pax (Allgemeine Morph. der Pflanzen, 100. 1890) says, when there are more than six parts to the whorl, the additional parts must have their origin in a division of the blades of the stipules.

It is argued from the presence of a median vein in the ligule of some of the grasses in which this organ is supplied with vascular support that it cannot be formed of two stipules grown together.

Hilburg, C.—Dissertation über den Bau und die Function der Nebenblätter. (Reviewed by F. Hildebrand in Flora, (II), 36 : 161–167. 1878.)

The general neglect of the subject of stipules and the timeliness of this dissertation is referred to by the reviewer.

The functions of stipules as protecting organs are discussed. They are considered under the heads of (1) those protecting the buds in winter, (2) those protecting the growing parts in the spring, (3) those which serve as protection against insects and other animals, (4) those which serve as well the function of assimilation.

The adaptation of most stipules in their form and manner of growth to the special function they are intended to fulfill and the apparent lack of function in others is remarked upon.

Clos, D.—Des Stipules et de leur rôle à l'infloresence et dans la Fleur. Mem. Acad. Sci. Toulouse, (VII), 10: 201–317. 1878.

This paper is the first part of an extended consideration of the subject of stipules. It deals with their occurrence in the families of plants and their importance in classification on account of the great variety of their characteristics.

Clos, D.—De la part des Stipules a l'infloresence et dans la Fleur. Comptes Rendus, 87: 305–306. 1878.

The stipular nature of the sepals in *Geranium*, *Helianthemum*, *Begonia*, *Oxalis*, *Alchimilla*, *Viola* and many other genera in different families is maintained.

Dixon, Alex.—On the stipules of *Spergularia marina*. Journal of Botany (Trimen), 7: 316. 1878.

Attention is called to the anomalous connation of the stipules of *Spergularia marina* Griseb. exterior to the petioles of the opposite leaves.

Clos, D.—Des Stipules considérées au point de vue morphologique. Bull. Soc. Bot. Fr. 26: 151–155. 1879.

Under this title a summary of the opinions of botanical authorities as to the true nature of stipules is given and the different theories are briefly discussed.

Various leaves have been considered as stipules, for example the primary leaves of *Asparagus* (Dutrochet), the first leaves of the branches of *Verbena aphylla* Gill & Hook. (Hooker, Bot. Misc. 1: 116. 1830) and of the Piperaceæ (C. DeCandolle, Mém. sur les Piper. 18–19, 1866), and the first two leaves of the axillary buds of many Solanaceæ.

The appendages sometimes accompanying the leaf in some Convolvulaceæ, as *Ipomea stipulacea* Sweet., have been considered as stipules (Jacquin. Pl. Hort. Schoenbr. Descr. et Ic. 2: 39. 1797).

Many have regarded stipules as leaflets, as for example in *Vibernum* (Baillon, Adans. 1: 372. 1860), and the lower leaflets in many plants have been taken for stipules, as in *Cobæa scandens* Cav. (Blume. Rumphia 3 : 142. 1837), and *Lotus tetraphyllus* Murr. (Linnæus, Trinius, E. Meyer, Fischer.)

In 1844 Wydler declared that stipules belong to the sheath and cites examples of transition between the two kinds of organs in the Rosaceæ, Polygonaceæ, Leguminosæ, etc. Stipules, in connection with the sheath have been ascribed to *Ranunculus*, *Isopyrum* and *Thalictrum* by Lloyd (Fl. de l'Ouest de Fr. Ed. 2, 1868), to *Caltha* by Wydler, Kützing (Grundz. der phil. Bot. 684, 1851–52) and Hooker. They have been recognized in the scales of the stems of the Aroids.

The so-called "decurrences" of leaves do not differ anatomically from stipules and are to be considered as identical with them, as for example in *Crotalaria*.

The tendril of the Cucurbitaceæ has been regarded as a stipule by Seringe (Mém. Soc. Hist. Nat. Genèv. 3 : 1–31. 1825), De Candolle (Organ. Veg. 1 : 336. 1827), Kirschleger (Flora, 28 : 615. 1845), Stoks (Ann. Nat. Hist. 1846), Payer (Elém. de Bot. 53. 1857–58), Parlatore, etc. Those of *Smilax* have been so considered by Cauvet (Bull. Soc. Bot. Fr. 12 : 241. 1865), but are looked on by Clos as "simple prolongations of the fibro-vascular bundles of the petiole without morphological signification."

The spines of the orange are considered as stipules by Du Petit-Thouars (Cours de Phytol. 47. 1820). Clos regards them as branches and those of *Amaranthus spinosus* L. as leaves, though they are considered stipular by Lamarck (Encyc. Meth. 2 : 118. 1786). *Ribes* shows stipular spines in some species. The spines of *Xanthium spinosum* L. mentioned by Sachs as occupying the place of stipules, Clos regards as representing pistillate flowers. He looks with disfavor on the doctrine that the glands at the base of the leaves in Resedaceæ, Cruciferæ, *Epilobium*, *Lyth-*

rum and some Euphorbiaceæ and Balsaminaceæ as well as the axillary hairs in some Portulacaceæ are stipules.

Clos, D.—Indépendance, developpement, anomalies des stipules; Bourgeons a écailles stipulaires. Bull. Soc. Bot. Fr. 26 : 189–193. 1879.

Stipules have been regarded as appendages of the leaf by Du Petit-Thouars (Cours de Phytol. 46, 1820), Aug. St. Hilaire (Leçons de Bot. 189, 1840), G. St. Pierre and F. J. Lestiboudois.

Clos agrees with Agardh in considering stipules as independent organs, giving as his reason that frequently in the Rosaceæ, Leguminosæ, Malvaceæ, Geraniaceæ, etc., the stipules persist alone, the leaves having completely disappeared, whether in the infloresence or at the base of stems and branches.

Under the head of the development of stipules the conflicting opinions of Mercklin and Trécul as to their time of appearance in relation to that of the leaf-blade is referred to. Agreement with Trécul is indicated and the evidence is not considered sufficient as a basis for the theory of the autonomy of stipules on the ground that they appear before the leaf-blade.

In consideration of stipular bud-scales reference is made to their recognition by Linnæus (Phil. Bot. Ed. 3, 52. 1790), Adanson (Familles des Pl. 246, 1763), De Candolle (Ann. Sci. Nat. (III), 5 : 321, 1846)* and Lindley (Veg. Kingdom, 283, 1846).

Göbel, K.—Beiträge zur Morphologie und Physiologie des Blattes. Pt. I. Die Niederblätter. Bot. Zeit. 38: 753, etc.—845. 1880.

This extended treatise deals with bud-scales and the scales of subterranean parts of plants and their homologies with leaves. Speaking of the primordial leaf Göbel says, "it is divided into two parts, a stationary zone which takes no farther part in the leaf-formation and a part out of which the lamina is developed." He calls these parts respectively the leaf-base and upper-leaf and states that the petiole arises after the formation of the blade and is inserted between the two parts.

Bud-scales are regarded as modified foliage-leaves and divided into those formed from the blade (*Syringa*), those formed by the leaf-base (*Æsculus*, *Prunus*), and those consisting of stipules (*Liriodendron*, *Quercus*). In *Prunus*, etc., the formation of the bud-scales by the union of petiole and stipules is denied on the ground that the continuous separate development of the petiole and stipules can be followed.

* See also Org. Veg. 2: 213. 1827.

The scales of rhizomes are divided into those formed by a development of the leaf-base (*Dentaria*, *Chrysosplenium*) and those formed by a modification of the upper-leaf (Labiatæ, Onagraceæ).

Colomb, G.—Note sur l'ochrea des Polygonées. Bull. Soc. Bot. Fr. 33: 506–507, 1886.

"The ochrea of the Polygonums is a complex organ formed of two parts: one opposite the leaf, the leaf-sheath, the other in its axil and detached from the petiole. This is a ligule." "Practically the same conditions prevail in the Gramineæ as in *Polygonum* with the difference that in the former the sheath proper is greatly developed and little prolonged beyond the insertion of the blade, while in the latter, the sheath proper remains short and is much prolonged above the petiole. By union with the ligule it forms an ochrea. So considered the ochrea is not peculiar to the Polygonaceæ. It is found also in *Ficus* and *Magnolia*, establishing the transition between the ochrea and stipules properly so called.

Vuillemin, P.—Apropos d'une recent communication de M. Colomb. Bull. Soc. Bot. Fr. 34: 141–142. 1887.

Commenting on the preceding paper, the author says that the leaf is primitively unifasciculate. The concrescence of a verticil of elementary leaves, such as occurs in the fossil *Asterophyllites*, gave a sheath analogous to that of *Equisetum*: the bundle of one of these elementary leaves becoming predominant and functioning as a midvein gave rise to an aggregate leaf, the first stage of a high differentiation. In this way the origin of the leaf-blade in *Polygonum*, *Platanus*, etc. is explained, while the ochrea, the homologue of the sheath of *Equisetum*, remains as a vestige of the primordial state.

Kronfeld, M.—Ueber die Beziehung der Nebenblätter zu ihrem Hauptblatte. Verhand. der Kais.-Konig. Zool.-Bot. Gesellschaft Wien. 37. Abhandl. 69–79. 1887.

The author has made investigations experimenting upon a large number of plants, by the removal of the lamina of the leaves at the earliest possible stage of development, in order to observe the effect upon the development of the stipules and so determine their physiological relation to the leaf-blade. Only in exceptional cases was the ultimate size of the stipules increased, and those where the stipules were normally foliaceous.

Colomb. G.—Recherches sur les stipules. Ann. Sci. Nat. (VII), **6** : 1–76. 1887.

This paper is the result of an exhaustive anatomical study of stipules and their homologues. The results obtained are of great interest and value. They are admirably summed up at the close of the paper as follows :

"When a leaf is sheathing, the sheath may be prolonged in a ligule situated above the point of insertion of the blade upon the sheath.

"In this organ three regions may be recognized :

"1. The lateral regions into which the marginal bundles of the sheath are merely prolonged. These regions naturally do not exist if all the bundles of the sheath enter into the leaf.

"2. The stipular regions, the bundles of which arise from a doubling of the last bundle of the sheath entering into the leaf.

"3. The axillary region, which unites the two stipular regions, a lamina, usually of parenchyma, but which may receive bundles arising from the internal doubling of those bundles of the sheath which become petiolar.

"The sheath may be reduced even to complete disappearance without a consequent disappearance of the ligule.

"1. If the ligule is complete with its three regions, I give it the name of an axillary ligule.

"2. If the stipular and axillary regions only persist, the sheathing regions having disappeared, we have an axillary stipule.

"3. If finally the axillary region divides into two halves, right and left (which would not be remarkable, considering its purely parenchymatous nature), the stipular regions exist alone at the base of the petiole, and we have then stipules properly so-called.

"Stipules and the ligule are then organs of the same nature, between which it is possible to find all forms of intergradation, the stipule being a portion of the axillary ligule.

"When, finally, the manner of origin of the bundles of the stipule is studied, we arrive at the following definition of the organ: An appendage inserted on the stem, at the base of the leaf, all the bundles of which arise exclusively from the corresponding foliar bundles."

Each of the tendrils of a leaf of *Smilax* is characterized as a demi-ligule, the "stipule" of *Potamogeton* as a ligule identical with that of grasses, the ochrea of *Polygonum* and *Platanus* as axillary stipules, the stipules of *Ficus elastica* Roxb. and *Magnolia grandiflora* L. as axillary ligules.

Ward, L. F.—The Paleontologic History of the Genus Platanus. Proc. U. S. Nat. Mus. 11: 39–42. 1888.

Professor Ward says (p. 41) in speaking of the fossil leaves of *Platanus basilobata* Ward, of the Yellowstone valley, that some of those found had "a remarkable expansion at the base of the blade, projecting backward on the leaf-stalk and having two to five lobes or points.

"These expansions are to be interpreted as evidence that the leaves all belong to *Platanus* or to some extinct ancestral type of the genus, since something quite analagous to them is found in our American plane-tree. The ordinary leaves of this tree are, it is true, destitute of basilar expansions, but those on young shoots, and sometimes those on the lower or non-fruit-bearing branches of trees exhibit this peculiarity.

"In place of this backward expansion of the blade many sycamore leaves have an appendage similar in shape at the base of the leaf-stalk, as though the once basilar appendage had been separated from the blade and crowded down the petiole to its point of insertion." This is shown in a short-petioled, wedge-shaped leaf from a young shoot of *Platanus* corresponding to the fossil form of *Platanus appendiculata* Lesq. from the auriferous gravels of California. The indication is that "the constriction seen in the fossil forms between the blade of the leaf and the appendage would seem to represent the beginning of this process of detachment."

Ward, L. F.—Origin of the Plane-Trees. Am. Nat. 24: 797–810. 1890.

The same cases as those in the preceding paper are discussed, the appendages in *Platanus appendiculata* Lesq. being described as stipular, while those of *P. nobilis* Newb. and *P. basilobata* Ward are not so considered.

Lubbock, Sir John.—On Stipules, their Form and Function. Jour. Linn. Soc. Lond. 28: 217–243. 1890.

"The primary function of stipules seems to be to protect the bud. In other species, however, they serve as accessory or deputy leaves. Their protective function is confirmed by the fact of their early fall. Some are more persistent than the leaves and protect the leaves of the following year.

"When stipules are present [in *Helianthemum*] the petiole is always very narrow, semiterete, and tapered to the base. Where they are absent the leaf is often sessile and, whether or not, its base is always dilated and concave on the inner face, completely enclosing the bud up to a certain stage of its development."

The presence of stipules in the lower imperfect leaves of *Ailanthus glandulosa* Desf. is noticed, though the family of the Simarubiaceæ has been described as exstipulate. In *Ribes sanguineum* Pursh. the bud-scales are described as consisting of the dilated base of the petiole, the lamina being represented by a small black point. "One or two succeeding leaves bear a small lamina sessile on the sheath, which is wholly adnate to the thin dilated base of the petiole and membranous, especially outside of the three vascular bundles. The next one or two have a well-developed lamina, and the sheaths partly separated from the petiole and corresponding to stipules. Farther up the stipular sheaths are shorter and wholly adnate to the petiole."

The form and function of the stipules in a large number of species are described.

Lesquereux, L.—U. S. Geol. Surv., Monog. No. 117: Geology of the Dakota Group. 1892.

Well-developed stipules of a species of *Betulites* from Kansas are described (p. 65) as having been found in their original connection with the leaf, and the discovery of leaves of a *Cratægus* with large undoubted stipules, from the Devonian of Wyoming is mentioned (p. 254). Speaking of a leaf of *Aspidiophyllum* (p. 232), Professor Lesquereux says, "the basilar appendage or pelta is like a primordial form of stipules, as in *Platanus basilobata* Ward of the Laramie group of Wyoming, *P. appendiculata* Lesq. of the auriferous gravels of California and definitively in *P. occidentalis* L. of the living flora."

Henslow, Rev. George.—On a Theoretical Origin of Endogens from Exogens. Jour. Linn. Soc. Lond. 29: 485–528. 1893.

The absence of vascular bundles in certain stipules is noted (p. 494).

Hollick, Arthur.—Wing-like Appendages on the Petioles of *Liriophyllum populoides* Lesq. and *Liriodendron alatum* Newb. Bull. Torr. Bot. Club, 21: 467–471. 1894.

These peculiar wing-like appendages are described and figured. Their similarity to the appendages in fossil species of *Platanus* as described by Professors Lesquereux and Ward is mentioned, and the probability suggested that we have here an explanation of the origin of the stipules of *Liriodendron Tulipifera* L. in the same manner as that indicated for those of *Platanus occidentalis* L. by Professor Ward. The presence of an unwinged portion of the petiole next to the blade in what is evidently the mature form of the leaves of *Liriophyllum*, and its absence in the immature ones is mentioned as tending to confirm the theory.

In commenting on this paper, the *Botanical Gazette* (19: 515. 1894) says, "The phyllopodium is to be regarded as an axis which has a tendency to develop wing-like appendages at any portion, notably, of course, in the epipodium. If stipules are branches of the hypopodium their origin has simply to do with the branching of that part of the phyllopodium, without any reference to the method of winging found in other regions."

Lubbock, Sir John.—On Stipules, their Form and Function. Pt. II. Jour. Linn. Soc. Lond. 30: 463–532. 1894.

This paper is a continuation of the author's former publication.

The presence of stipels in *Sambucus Ebulus* L. is noticed. The membranous protective margins of the sheath in *Thalictrum aquilegifolium* L. and the "membranous stipular processes at each trifurcation of the lamina" are mentioned, the latter "appearing to differ somewhat in their origin from the primary sheath." In treating of *Ranunculus aquatilus* L., the author says, "The terminal bud is enclosed by the stipules of the two uppermost expanded leaves. The developing leaves push their way out at the apex of the stipular sheath. Similarity of conditions have therefore developed in the aquatic Ranunculaceæ, an arrangement very similar to that of the Potamogetons."

The following remarks are of particular interest: "In *Magnolia glauca* L. the winter bud is covered by a pair of connate stipules adnate to a petiole that is less than half their length. Succeeding leaves are perfect, and the stipules are two or three times as long as the petiole, the free portions being connate by both edges, like a candle extinguisher, over the bud, so that the leaf appears to spring from the back. As they are adnate to the petiole, there is some reason to assume that the stipules once formed a sheath pure and simple to the leaf of some ancestral form."

Franke, Martin.—Berträge Zur Morphologie und Entwicklungsgeschichte der Stellaten. Bot. Zeit., 54: 33–60. 1896.

In the part of this paper which treats of the development of the leaf-whorl the author agrees with Eichler that the stipules originate later than the principal leaves. But he says that in the species having four-leaved whorls never more than four prominences arise to develop into the parts of the whorl, and that if the parts number six or more, there is a distinct prominence for each. In the last case the supernumerary stipules first make their appearance in the course of development of the whorl a little later than the first pair of stipules.

Hollick, Arthur.—Appendages to the Petioles of Liriodendra. Bull. Torr. Bot. Club, 23: 249. 1896.

The author, referring to his former paper, describes and figures some abnormal leaves of *Liriodendron* collected from saplings, seedlings and new shoots from old stumps. One in particular of these leaves is of interest on account of its similarity to the fossil leaves of *Liriophyllum populoides* Lesq. both in the form of the lamina and especially in having a short petiole with broadly winged margins which extend from the base of the petiole and connect with the base of the leaf-blade.

The question is put whether in this case we have "stipules adnate to the petiole and leaf-blade, or portions of the leaf-blade which are acting the part of stipular appendages."

Such, in brief, is the import of what has been written on the subject of stipules, so far as I have been able to learn. The results of my own observations are not at variance to any very considerable degree with the opinions of most of the botanists who have studied the subject carefully, as will appear from the following exposition of my investigations and the conclusions at which I have arrived. To these I shall pass at once, deeming unnecessary farther comment on previous writings, except such as the statement of my results may imply.

The Nature and Origin of Stipules.

Though it is not part of the purpose of this paper to discuss the problem of the phylogeny of the plant world, it is nevertheless necessary in order to define our field of inquiry to make a brief statement concerning the probable relationship of the higher forms, namely of those in which foliar organs are developed, including in the widest interpretation the Characeæ, Bryophyta, Pteridophyta and Spermatophyta.

As, in the Characeæ and Bryophyta, the plant body represents the gametophyte stage of development, there can be no homology of the leaves of these plants with those of the Pteridophyta and Spermatophyta in which the plant body is the sporophyte. For this reason the so-called stipules of the Charas, together with the basal lobes or saclike and straplike appendages of the leaves of many Hepaticæ need not be taken into consideration.

Accepting the general theory of evolution in nature, we must admit that the origin of all the higher plants is algal, but just what the relationship of the Pteridophyta to the Spermatophyta may be is still an open question. The same is true in greater or less degree of the affinity of the Monocotyledones, Dicotyledones and Gymnospermæ in the latter group.

This question of relationship is of considerable importance in connection with the problem before us as determining the homology of the foliar appendages in the several groups. The evidence in support of the doctrine of the common origin of all the Angiospermæ is particularly strong and may be considered as conclusive. But the relationship of the Gymnospermæ to the Angiospermæ is more remote, and that of the Pteridophyta still more so- and, though there are many points of resemblance, the similar characters may be cases of parallel development rather than indications of a common origin. It is my present opinion, however, that the Gymnospermæ sprang from some generalized hetero, sporous Pteridophyte,* that the early Angiospermæ were differentiated from related forms, and that therefore, the foliar organs in the three groups may be considered as homologous. But this homology can apply to the leaves of Pteridophytes in a very general way only, namely, to such undifferentiated forms of leaves as the ancestors which gave rise to the early Gymnospermæ and Angiospermæ may be supposed to have had. While, therefore, the foliar organs in the three classes are to be considered homologous in their origin, they cannot be so considered in their differentiation and the evolution of leaf-forms in the Pteridophyta and Gymnospermæ, though analogous in many points to their evolution among the Angiospermæ, should be regarded as independent. We may then consider the "stipule" of the Ophio-

*See Campbell, Mosses and Ferns, 300. 1895.

glossaceæ, Marrattiaceae and Osmundaceæ and the "ligule" of *Selaginella* and *Isoetes* as special developments and as properly placed in a separate category from the appendages bearing these names among the Angiospermæ. The Gymnospermæ present nothing to represent either stipule or ligule and we have left for our special consideration the ligule, stipule and their homologues as they occur in the various groups of the Angiospermæ only.

Having thus defined our field, we should have, for the considoration of the problem before us, some conception of what sort of plant the earliest Angiosperm was. In the absence of geological evidence this conception must be purely hypothetical and, basing it on a generalization which would admit of the differentiation from it of all the varied forms of the modern group of Angiosperms, we can see that it must have been a plant of very simple organization indeed. For our present purpose we need not concern ourselves with any other organs of this primitive Angiosperm than the leaves which, from the point of view of the proposed generalization, must be conceived of as hardly more than the bare rudiments of leaves, mere sheathing scales at the nodes of the plant, serving slightly, if at all, the function of assimilation which was still subserved, as in its ancestors, by the general surface of the plant, but confined chiefly to that of protection. The primitive leaf was probably parallel-veined or approximately so, giving rise in its earlier differentiation to the parallel-veined leaves of the Monocotyledones. The geological evidence indicates that these appeared before the Dicotyledones* which must have sprung from them later at one or more unknown points, and netted-veined leaves are of a more recent evolution. Consequently the tendency of aquatic Dicotyledones to revert toward monocotyledonous structure is rather a case of atavistic degeneration than an indication of the origin of Monocotyledones from Dicotyledones in ancient times through the effects of aquatic habit.†

Now, as advance in evolution proceeded, the need of greater assimilative capacity arose and, as the foliar organ was the one best

*Professor L. F. Ward. Sketch of Paleobotany. Fifth Ann. Rep. U. S. Geol. Surv. 448, 1885. Professor A. C. Seward, on the contrary, does not believe that we have satisfactory evidence of pre-Cretaceous Monocotyledones. Notes on the Geologic History of Monocotyledones. Annals of Botany, 10 : 220. 1896.

†See Rev. George Henslow. Jour. Linn. Soc. Lond. 29: 485-528. 1893.

adapted for specialization in this direction, it was the one upon which the office devolved. Every botanist knows what an endless variety of forms and special adaptations of particular foliar parts have arisen in the course of evolution which was inaugurated when this setting aside of the leaf to bear in future the weight of the assimilative function took place, or rather when this additional function was placed upon it, for the old protective function has always been retained, though it has become less noticeable as the new function has overshadowed the old.

There has been in the line of vegetable descent a progressive development of the foliar organ, and a history of this development, together with that of other organs, if it were obtainable, would give us a complete phylogeny of the flowering plants, and leave no morphological problem unsolved,* but as the geological record is very incomplete, and we have in the lower Cretaceous an already well developed and much differentiated angiospermous flora of the earlier history of which almost nothing is known, we must seek other sources of information in determining the homologies of parts. At this juncture we may safely follow the example of the zoölogists and turn to embryology for the evidence which geology, as yet, refuses to give except in fragments Among animals, as the phylogeny and ontogeny are found to parallel one another, so we may feel confident they will be found to do among plants when the geological record shall be more completely unearthed.

It has become a well established part of the theory of evolution that each individual organism epitomizes more or less fully in its development the historical steps in the evolution of the type to which it belongs.† By the application of this law of re-

* "On this same view of descent with modification most of the facts in morphology become intelligible, whether we look to the same pattern displayed by the different species of the same class in their homologous organs, to whatever purpose applied, or to the serial and lateral homologies in each individual animal and plant." *Charles Darwin*, Origin of Species, 1859. Am. Ed. 6, 2: 264. 1889. See also p. 239, *et seq.*

† This theory, known as Von Baer's law, was promulgated by that scientist in his Ueber Entwicklungsgeschichte der Thiere, 224. 1828–37.

See also F. M. Balfour. Comparative Embryology. Ed. 2, 1: 2. 1885.

Opposed to this law is Adam Sedgewick. On the Law of Development commonly known as Von Baer's Law. Quar. Jour. Mic. Soc. (II), 36: 35. 1894.

capitulation to the development of plants we may arrive at valuable and trustworthy conclusions. The question would at once be asked, where shall the embryology of the flowering plants be studied, and the answer would naturally be, in the development of the seed in the ovary. And here indeed, we trace in outline an epitome of the course of development from the simple unicellular organism, represented by the fertilized egg-cell of the ovule to the highest thalloid form, the "embryo," with its bud (plumule) which is to develop into the full-formed plant perfect in all its parts. For a summary of the further development of the Angiosperms we must look to the growing bud which is the essential reproductive organ of the sporophyte stage and, doubtless, a more primitive one than the seed, for it is common among the more ancient Pteridophytes and these have no seed. The embryo of flowering plants does, however, correspond pretty closely to that advanced stage of development of the egg-cell of some of the higher Pteridophyta now generally spoken of as the embryo and should be regarded as a young plant in a state of arrested development. In this state it remains during a period of rest, in a highly specialized environment in the seed, awaiting favorable conditions for farther growth. Because of the highly specialized environment of the embryo, it has itself become correspondingly specialized and has been variously modified to suit the special conditions of its surroundings. The plumule cannot then be regarded as any longer representing a primitive form of bud and its development is so altered by secondary modifications that the series of phylogenetic changes is disguised and imperfectly represented. A parallel case is found among animals in the development of Echinoderms, in which the changes that have taken place through secondary modification are so great that the relationship of the group cannot be satisfactorily determined by developmental evidence.

It is not then in the seedling that we should expect to find representations of primitive leaf-forms, though later ancestral forms paralleling those of fossil leaves, of which we shall speak, are found in some seedlings, as for example in *Liriodendron*. But it is in the growth of the less specialized buds developing under more primitive conditions that we should expect to find them. Such buds are the ordinary leaf-buds of perennial plants, and especially those occurring on basal and subterranean portions which I conceive to develop under conditions somewhat more primitive than is the case with aërial buds. But in both these the recapitulation of the development of leaf-forms may be traced with a considerable degree of confidence, from the primitive sheathing protective scale to the most highly differentiated and complex of modern leaf-forms.

It is at this point that the fragmentary geological evidence sheds its strongest light on the problem under consideration. In the Cretaceous and Tertiary floras which preceded the modern, the present degree of differentiation had not as yet been attained and but few modern species made their appearance before the close of the Tertiary.* The species, however, which immediately preceded those which now exist were very closely related to them, being their immediate ancestors, and differed from them only in showing a somewhat lower degree of differentiation, and their leaf-forms are accordingly more primitive than those of the existing species which have descended from them.

Now it is a well-established fact that the lower leaves of young branches and shoots, and especially of those which spring from the stumps of felled trees, are frequently unlike the adult forms which occur higher up and bear a close resemblance to the fossil leaves of extinct species, so close indeed, as oftentimes to be indistinguishable from them. This is strong evidence in favor of the doctrine that the lower foliar organs represent not reduced leaves, as botanists have commonly supposed,† but the primitive foliar organs, and that in an ascending series from the lowest scale to the mature adult leaves of the upper part of the stem, giving a more or less perfect summary of the phylogenetic development of the foliar organ from the most primitive type upward to the most highly differentiated.‡ In other words, a single stem may represent the whole phylogeny of the foliar organs of its type. It is true that there are simple leaf-forms which have become so

* Our modern species of *Corylus* are recorded from the Eocene by Professor J. S. Newbury. Later Extinct Floras of North America. Ann. N. Y. Lyc. Nat. Hist. 9 : 59–60. 1868.

† See DeCandolle. Org. Veg. 2 : 212. 1827.

‡ "Most modern botanists now regard the varying forms of leaf seen on young shoots and near the base of trees as valuable hints at the probable stages through which the final forms have passed in the history of their development." Professor L. F. Ward. Proc. U. S. Nat. Mus. 11 : 11. 1888.

by reduction but, as an organ cannot be reduced until it has been developed, these are to be looked for above and not below the perfect leaves, and are found in bracts, involucral scales and the parts of floral envelopes, reduction taking place in inverse order to the course of development, and only the most primitive structure, the simple sheath, persists in the petals of most flowers. Reduced leaves are also common in parasites, and in the flora of desert regions as is well illustrated in some of the Leguminosæ of Australia the leaves of which are little more than spines, or are developed into bladeless phyllodia, while in the seedlings the ancestral pinnate or bipinnate forms occur.*

We thus have shown in each season's growth of a plant, though not clearly in annuals because disguised in the seedling, a more or less complete series of foliar organs which may for illustration be compared with the vertebrate series among animals, the lowest leaf-scales being comparable in degree of development to the simple structures of the fishes and the most highly developed leaves to the complicated ones of mammals. Each leaf in the series is equally perfect for the function it is intended to perform, but the lowest of a lower type of organization, as are the fishes, and representing an earlier stage in the phylogenetic series.

Now in animals we look to the developing egg of the more generalized fishes for the least abbreviated embryological recapitulation of the early development of the vertebrate branch, for in the mammals the early stages are passed through so rapidly and with so many disguises as to be of comparatively small importance in giving the history of the branch, unless viewed in the light of the embryological development of the lower types. So the lower foliar organs of a branch or shoot are embryologically of far greater importance than the upper, for in the beginning of the development of one of the upper leaves we have but the early stages of a highly organized appendage. These early stages are consequently abbreviated and more or less disguised. The formation of the stipules in the growth of the upper leaves is therefore not a salient point in the consideration of our problem though it has had much stress laid upon it, yet it is of interest to note that in general the stipules appear earlier than the leaf-blade, thus giving evidence that they are of more ancient origin. It may be added,

* See Sir John Lubbock. On Seedlings. 1: 474. 1892. See also p. 440 as to the similar case of *Lathyrus Aphaca*.

and it is a matter of common observation, that the petiole is the last portion of the leaf to develop ontogenetically and is therefore to be regarded as the most recent part to be added phylogenetically. This helps to explain the common occurrence of sessile and petiolate leaves even in different species of the same genus, as variation more readily occurs in recent than in ancient structures, while on the contrary it has been a matter of remark among even the earlier botanists that stipules when they occur usually characterize all the species of a family, an additional evidence of the antiquity of their origin.

Let us now take up, in the light of the foregoing conclusions the consideration of the destiny of the primitive foliar organ as it has been modified and developed in the course of evolution. For convenience in making our inquiry, I would divide the primitive leaf into the central-basal, axial, apical and lateral portions. Each of these figures prominently in the evolutionary history of foliar organs, for from the original condition there has been progressive development along several lines of varying degrees of relationship and the morphological result of the development of the several parts has been quite different in the divergent groups, so much so as to render the question of homology a doubtful one to many minds. We shall endeavor to establish its reality.

The lamina of the leaf, as we shall see, has been developed chiefly from the apical portion, usually from scarcely more than a mere point, though it may also include the axial and lateral portions. The true petiole, when present, is developed from the axial portion,* the sheathing petiole from the central basal together with the lateral portions, stipules and structures of the same signification from the lateral portions. It is with the lateral portions, therefore, that we are chiefly concerned.

With reference to the formation of stipules there are three principle types of leaf-development: that in which the several portions of the primitive leaf have developed together into a simple unappendaged blade, that in which a sheathing petiole is formed with or without a ligule or ochrea, and that in which stipules properly so-called are present.

In the first and simplest case the development of all the parts

*See S. H. Vines. Text-book of Botany, 1: 49. 1894.

together gives rise to such leaf-forms as are found in *Vaccinium* and *Sassafras*, the principal portion of the lamina being formed by the development of the apical portion, but including at the base the lateral, central-basal and axial portions which are contracted below into a short petiole.

If we observe the development of the leaf in *Sassafras* the relative growth of the several parts can be readily traced. The first four leaves (fig. 1) are very simple. In the fifth (fig. 2) considerable development has taken place. The apical portion, now forming about half of the organ, is provided with the three typical veins as they appear in the adult leaf, but starting out separately from the very base. The lateral portions have reached their highest development and each is furnished with a pair of veins. In the sixth leaf (fig. 3) there is a very close approach to the adult form. The upper part has expanded and the lower parts have elongated, removing the point of separation of the three principal veins of the leaf to a considerable distance from the stem. At the same time there has been a basal contraction looking toward the formation of the petiole with a considerable degeneration of the lateral portions, one of the veins having disappeared from each of them, while the other has become associated with the midvein. The seventh leaf (fig. 4) represents the unlobed adult form and differs but little from the sixth.

A similar condition is observable in *Ailanthus glandulosa* Desf. (figs. 5–10), but resulting in this case in the final separation of the lateral portions as small gland-bearing fugacious stipules, comparable to those at the base of the leaves of many of the Ranunculaceæ. The comparison of *Sassafras* and *Ailanthus* shows how small a difference in development may determine a leaf as stipulate or exstipulate.

The case of *Syringa vulgaris* L. is like that of *Sassafras*, though more difficult to trace, owing to the larger number of veins in the leaf, but the homologies of parts may be followed more or less distinctly from the second leaf up to the sixth, the first adult leaf (figs. 11–14). The lateral portions are seen to have degenerated almost entirely and, their bundles having disappeared, they remain only in the margin of the petiole.

The Compositæ furnish examples of a similar course of development but often with a closer approach to the true stipular condition, as the lateral portions are supplied with vascular tissue by small branches coming off at the base of the leaf from the main lateral bundles.

In *Erigeron annuum* (L.) Pers., for example, there are three fibro-vascular bundles in the leaf-trace which pass up through the central portion of the petiole, converging as it narrows. But almost immediately on their departure from the stem each of the lateral bundles gives off a branch in the same manner as when true stipules are present. This branch forks at once and supplies the wings of the petiole. In the cauline leaves (fig. 15) its branches can be distinctly traced into the lower lobes of the leaf. The basal leaves of *Aster undulatus* L. show a condition very closely similar to that found in *Erigeron annuum* (L.) Pers., but in the cauline leaves there is a considerable modification by which the large lobes of the base of the petiole (fig. 16) are formed. The stipular bundle curves outward through the lobe giving off branches which form a net-work supporting its parenchyma. It then passes up through the wing of the petiole and into the basal part of the leaf. In *Solidago juncea* Ait., there are eleven bundles in the leaf-trace and a stipular bundle is given off on each side, supplying the margins of the petiole. *Artemisia vulgaris* L. affords a very interesting variation. The lateral portions of the primitive leaf have branched in a very curious manner (fig. 17), forming several small leaflet-like appendages to the base of the petiole. That they belong to the lateral portions and are stipular in their character is shown by the fact that they are supported by branches of the stipular bundle which is given off a little higher up than in *Erigeron*, passes on through the wings of the petiole after giving off the branches and enters the base of the blade as in other cases. This is the nearest approach to the true stipular condition that I have observed among the Compositæ.

The embryonic development of the foliar organ among the Compositæ is in general too much abbreviated to give much evidence in the consideration of the present question, and it should be so expected from the position which the family holds at the head of the vegetable kingdom.

Petioles of the kind seen in this type of leaf-development are very often short and usually more or less margined or winged by the contracted basal parts of the lateral portions of the primitive leaf. They are evidently genetically different from the petioles of stipulate leaves which are developed by the elongation of the axial portion alone. Sessile leaves also are of this type, hence the absence of stipules, the stipular tissue being incorporated into the basal part of the blade. But even where stipules are present, the lateral basal portions of the leaves are often in the closest anatomical relation with the stipules. This may be seen in *Viola obliqua* Hill (fig. 18) in which, near the bundle which passes into the stipule, a similar one arises, takes its course up the petiole supporting its narrow wing and is distributed to a small part of the basal portion of the lamina. We shall find several cases similar to this when we come to the consideration of the Rosaceæ. There is in this a suggestion of the occasional separation of only a part of the lateral portions to form the stipules and the incorporation of the remainder into the petiole and blade.

The second case is that of the sheathing petiole as it occurs in the Graminæ, Araceæ and Umbelliferæ. In this case the central-basal portion of the primitive leaf is very largely developed and with it the lateral portions which form the margins of the sheathing petiole. The lamina and true petiole are later developments of the apical and axial tissues. We are strongly supported in this view by the fact that the sheathing petiole is interchangeable with petioles of the ordinary type accompanied by stipules. This occurs in the Umbelliferæ. In *Hydrocotyle* and a few other genera the sheathing petiole is wanting and stipules are present. The closely related *Aralia racemosa* L. also has stipules. Still more striking is the case of *Comarum palustre* L. in which the basal leaves have the sheathing petiole remarkably developed with no indication of stipules (fig. 19), while the upper leaves possess well developed stipules adnate for not more than half their length (fig. 20).

But the identity of the marginal tissue of sheathing petioles is perhaps best shown in the Ranunculaceæ. In the upper basal leaves of *Ranunculus bulbosus* L., the separation of the lateral portions is seen actually to have begun, presenting exactly the appearance of adnate stipules. The development can be clearly traced from below upward. The first leaf has a short sheathing petiole of the ordinary type (fig. 21). This is slowly modified till in the fourteenth leaf (fig. 22) the vascular bundles have drawn closer together, the sheath has grown shorter and the broad lateral portions, hyaline in texture and requiring no special support other than that of the surrounding leaves, are rounded off distinctly at the top at the point of beginning of the true petiole. In the fifteenth leaf (fig. 23) there is a further reduction in size and the tips of the lateral portions are free. Another interesting case among the Ranunculaceæ is that of *Thalictrum polygamum* Muhl. in which the sheathing petiole is of a very generalized type (fig. 24). The lateral portions are chiefly hyaline, though sometimes faintly netted-veined and their margins turn in at the apex and meet in the central dorsal channel of the petiole at its base, forming a ridge between the sheathing and true petioles. This ridge supports a very narrow hyaline membrane which appears to me as the rudiment of a ligule. It would become typical by a little further development of marginal tissue. I believe this to be the origin of the ligule wherever it occurs, though it does not appear so clearly evident in highly specialized groups, nor should we expect such to be the case. There is also present at the first and second forkings of the petiole a transverse hyaline scale very much like a ligule.

It is noteworthy that the ligule always occurs in connection with the sheathing petiole, as in the Gramineæ and Cyperaceæ, or where there is evidence that there has been a sheathing petiole which has disappeared by degeneration, leaving the ligule axillary as in some of the Naiadaceæ which we shall presently consider.

When the ligule has developed sufficiently to require special support, it is supplied by the introduction of vascular bundles. These bundles have their origin most frequently as tangential branches of the main leaf-bundles at their point of passage from the sheathing petiole into the true petiole, or, where the latter is undeveloped as in the grasses, into the blade. This mode of origin of the ligular bundles is seen in some of the tropical grasses and in the ligular portion of the stipule of the Naiadaceæ and the ochrea of the Polygonaceæ. *Richardia* shows an exceptional venation of the ligule.

The best marked examples of the sheathing petiole among the Monocotyledones are found in the Araceæ, the Cyperaceæ and the Gramineæ. If we examine a developing plant of the common hot-house calla (*Richardia Africana* Kunth.), the first leaf (fig. 25) is seen to be a short, broad sheath, the second (fig. 26) has increased to a considerable length and the apical and axial tissues have developed into a minute blade and petiole. The third leaf is of the adult form, but smaller, though all the parts have increased very much in size. This is contrary to what is observed in *Ranunculus* where the sheathing petiole degenerates while the other parts advance. The margins of the sheathing petiole of *Richardia* curve inward at their apices and meet in the middle line of the leaf as in the case of *Thalictrum polygamum* L., but they are much broader and form a distinct ligule which is supported by the incurving and union of the marginal veins of the sheath instead of by tangential branches. In *Arisæma triphyllum* (L.) Torr., the transition is not so well marked, owing to the small number of leaves the first of which is but a sheath as in *Richardia*, while the second bears a mature lamina.

Scirpus polyphyllus Vahl. (fig. 27) will serve well to illustrate the ligule in the Cyperaceæ. It is but little developed as a slight hyaline outgrowth upon the ridge at the union of the sheath and lamina, but the sheath is closed, as is typical in the family. and a little farther development of marginal tissue would produce an ochrea. Typical of the ligule in our common grasses is that of *Phalaris arundinacea* L. (fig. 28). It consists of a considerable outgrowth of hyaline tissue which is continuous laterally with the marginal hyaline tissue of the sheath. This continuity strongly supports the position taken as to the origin of the ligule. The purpose of the ligule is evidently to prevent the flow of water from the upper parts of the leaf down between the sheathing petiole and the stem which together with the axillary bud it invests and protects, and neither the ligule nor the primitive ridge which bears it are found in those cases where the sheathing petiole does not closely invest the stem, at least in the early stages of growth, and its purpose could not be in any considerable measure fulfilled.

The usually axillary position of the "stipule" in the Naiadaceæ has occasioned considerable discussion as to its real relation to the ligule of grasses and to stipules proper. That it is in reality a development of the lateral portions of the primitive leaf, and that it corresponds to the ligule together with the margins of the sheathing petiole of grasses and is rendered more or less nearly axillary by the degeneration of the central-basal portion, becomes clear from the fact that in some species of Naiadaceæ the sheathing petiole retains a considerable degree of what should be regarded as its ancestral development, and a condition approaching that which occurs in grasses is found. *Potamogeton crispus* L. is one of our species which will serve well for an illustration. The first leaves do not develop a blade, but the lateral and central-basal portions are well developed. In the adult leaves there is present a true sheathing petiole (fig. 29). The fibro-vascular bundles of the central-basal portion pass into the blade, giving off tangentially, at the point of transition from sheath to blade, the bundles of the ligular part of the stipule. The bundles of the lateral portions do not in this case curve about to join those entering the blade but are prolonged upward, remaining parallel and supplying the lateral portions of the stipule with supporting tissue directly. In *Althenia filiformis* Petit. (fig. 30), the conditions are more primitive in the larger relative development of the lateral and central-basal portions. In *Ruppia* the ligule is not developed, and the tips of the lateral portions are free as in ordinary adnate stipules.

The condition found in *Potamogeton* is almost exactly repeated in *Polygonella articulata* (L.) Meisn. (fig. 31). The ochrea is cylindrical, surrounding the stem. The central-basal portion is long and narrow, bearing at its apex the terete lamina which is deciduous before flowering. The lateral portions form the principal part of the sheath, are parallel veined with a few anastomosing bundles and are prolonged above the central-basal portion, growing in along the ridge between it and the lamina. This middle portion shows its origin by a deep median sinus and receives its bundles typically as tangential branches from those entering the lamina. We do not have then in *Polygonella* a typical ochrea as it occurs in *Rumex* and *Polygonum*, where, because of the small development of the central-basal portion, the sheathing petiole is very short or almost wholly wanting. The lamina, being of much greater importance than in *Polygonella*, receives all the bundles of the leaf-trace. They are more or less abruptly deflected into the true petiole, generally developed in these genera, according to the degree of degeneration of the central-basal portion. The lateral portions receive their supporting bundles as branches of the lateral ones of the leaf-trace. In *Polygonum sagittatum* L. (fig. 32), the marginal tissues do not extend across the petiole and we have a stipule opposite the leaf. In *Rumex crispus* L. (fig. 33) and *Polygonum Virginianum* L. (fig. 34), the ochrea is complete and the axillary parts receive the typical tangential bundles.

The ochrea of palms is doubtless of the same character, though I have not had opportunity to examine its anatomical structure. In those species which I have examined morphologically, the case is that of the ochrea associated with a remarkable development of the sheathing petiole. There is no true petiole and the ligule may be seen even a little above the base of the blade on the upper surface of the midrib. From this point the lateral portions may be traced down the margins of the sheath, though dried up and very much torn and broken by the more rapid development of the central tissues, till they unite with those parts which in their development have formed the "ochrea." The degeneration of the sheathing petiole with the probable concomitant formation of a true petiole would give the same conditions as in *Polygonum* with its typical ochrea.

The ochreate stipule of *Platanus* differs little morphologically from the typical ochrea, except in the absence of development of the central-basal portion and the possession of a horizontal limb, but there is no fibro-vascular support for the ligular part and this usually splits, leaving apparently a single stipule opposite the leaf.

The case of the tendrils of *Smilax* is one which has occasioned much discussion, but the embryological together with the anatomical characters make it sufficiently clear that in *Smilax* the tendrils are true stipules found in connection with the sheathing petiole. If a young shoot of *Smilax rotundifolia* L. be examined, the first leaf (fig. 35) is seen to be of the typical primitive form. In the second (fig. 36), the apical portion has developed into a blade of considerable size and there is a well-marked sheathing petiole. In the third (fig. 37), the true petiole has begun to develop, the central-basal portion is degenerating and at the same time the lateral portions have begun to separate, forming rudimentary tendrils which in the adult leaves come to considerable length by secondary development in adaptation to their new and unusual function of support. In cross section the bundles of the tendrils are seen to arise as branches of those of the petiole, so that anatomically, as well as embryologically, they answer to true stipules.

Pastinaca sativa L. (fig. 38) furnishes a good example of the sheathing petiole among the Umbelliferæ. The lateral portions are broad and furnished with several vascular bundles parallel with those of the central basal portion. The lateral portions remain of considerable breadth to the top where they are distinctly rounded off, and their bundles, with the exception of two or three of the exterior ones, curve around and unite with those entering the petiole. This free condition of the exterior lateral bundles with the anastomosing network between them shows a considerable degree of approach to the true stipular condition.

In the third case true stipules are developed. They are formed by a very early separation of the lateral portions from the main body of the primitive leaf, a separation which can be very clearly traced progressively in the embryological history of leaf development. The function of the lateral portions in their primitive connection with the main body of the foliar organ is, in common with the other portions, protective, and while the apical portion, having had placed upon it the special function of assimilation, goes on in its development together with the accessory axial portion in adaptation to this purpose, the lateral portions usually serve their ancient function only, sharing it with the central-basal portion when this has not disappeared by degeneration. The central-basal portion also supports the main body of the leaf, a function from which the lateral portions have been freed by separation.

It is in consequence of this separation that all the main vascular bundles of the leaf-trace in the third type of leaf-development are deflected toward the central one that they may pass up through the petiole into the lamina and give the required support to these important parts. The support of the lateral portions is left to comparatively small lateral branches from the two exterior bundles of the trace, evidently developed expressly for the purpose. This we may conclude, since vascular tissue is the most modern of plant tissues and introduced because of the necessity of support in the evolutionary development of the primitive ground tissues. It would, therefore, follow and not precede the evolution of leaf-forms, being introduced where needed and disappearing again when degeneration or other support of particular parts renders its presence unnecessary. This will appear in some of our examples. In the first and second types of leaf-development the lateral portions may retain in greater or less degree their independent venation.

As the other portions of the primitive leaf have been so wonderfully modified in the course of their development and altered from their original condition, so the freed lateral portions to which we may now apply the term *stipules* have not retained their primitive proportions in adult leaves nor the identity of all their parts. But as the central basal portion has often almost wholly degenerated, the same thing has happened to the basal parts of the lateral portions. The parallel degeneration of the two portions has brought the stipules into closer and closer apparent relation to the stem, so much so as to lead to the enquiry whether they are not accessory leaves and to suggest their origin from the reduction or lack of development of a portion of the leaves as in *Selaginella* and their subsequent association in close relation to the larger ones, but in all my investigation I have not found the slightest evidence in support of this theory. The degeneration of the stipules may continue until they become vestigial or finally disappear altogether. This is evidently the case in those families of plants a few species only of which still possess stipules, as for example the Caprifoliaceæ.

But opposed to the basal degeneration of stipules, there has very commonly been a longitudinal development corresponding to that by which the lamina has been evolved. This has resulted in the adaptation of the stipules to the peculiar requirements of each genus and species. Often in this secondary development they remain membranous, serving the protective function only, and when free are early deciduous. But in numerous cases they have acquired the assimilative function also, developing abundant chlorophyll and sometimes, as in the pea (*Pisum sativium* L.), becoming of equal assimilative importance with the lamina. In *Lathyrus Aphaca* L., they even replace it almost entirely.

Among all these varying forms we should expect to find closer similarities in those plant groups of nearer relationship as we do in floral structures, and conversely these similarities of foliar development should also point to relationship, due allowance being made for parallel development in adaptation to similar environment and for secondary functional modifications which find morphological expression. Also in types more recently evolved and more highly differentiated wide divergence from the typical mode of development may be looked for. The Caprifoliaceæ, before mentioned, are of such a type, with stipules usually wholly aborted;

another is the family of the Rubiaceæ with anomalous stipular development in the group of the Stellatæ. The oaks also, though of lower organization, are an advancing type and still actively undergoing differentiation as evinced by the close relationship and difficulty of determination of the species of any given group. In this genus all but the upper part of the primitive leaf has disappeared by degeneration even in the earliest stages represented in embryonic leaf-development, and the well developed stipules are distinct and separate from the very base of a developing shoot. Not until the fifteenth node, in *Quercus rubra* L. (fig. 39), is there any appearance of lamina. The apical portion of the protophyll must however be regarded as potentially present between the stipules at their base. It begins its development unusually late in the series and exhibits several stages, of which the twentieth leaf (fig. 40) is illustrative, before reaching adult size. The axial portion of the protophyll being aborted, the petiole, here again a short one, is formed by the contraction of the basal part of the lamina itself. The case of *Fagus* is very similar, but the lamina appears as early as the eighth node (fig. 41), indicating a less degree of specialization. In related genera a different course has been followed. The lamina develops still earlier and the stipules of the lowest nodes are united, separating only on the appearance of the first accompanying lamina.

In the family of the Juglandaceæ the genus *Hicoria* furnishes a very interesting example. The lower foliar organs are of the primitive type with an unusual development in size in some species. The transition to the adult leaf-form is commonly rather abrupt, but I have observed, in both *Hicoria alba* (L.) Britton and *H. microcarpa* (Nutt.) Britton, the frequent occurrence of intermediate forms, the lateral portions remaining as typical adnate stipules (fig. 42).

I have not seen the typical representation of embryonic leaf-development better exemplified than in the case of *Baptisia tinctoria* (L.) R. Br. where at a glance one is struck with its clearness. It is also especially full and accurate as occurring in the development of subterreanean buds. The first five leaves are extremely primitive, completely surrounding the node, though only slightly developed on one side. The fifth (fig. 43) shows at its apex a minute apical tooth, the beginning of the lamina which is farther developed in the sixth leaf. In the seventh (fig. 44) the three leaflets are plainly distinguishable, the petiole has begun its development and the separation of the stipules has made considerable advance. The ninth leaf (fig. 45) is well developed, with the large stipules still showing considerable adnation. But in the tenth (fig. 46) they are wholly free and much reduced, and higher up disappear altogether. We could hardly have a more complete series in illustration of the formation of stipules than this, giving as it does all the stages from an extremely primitive leaf-form to that very highly organized condition where the stipules have entirely disappeared. By a comparison of the venation in the seventh and ninth leaves, it will appear that the separate condition of the stipules has been attained in the manner already described, partly by the formation of an apical cleft, partly by the degeneration of the central-basal portion bringing the base of the cleft lower down. Meanwhile there has also been a considerable apical development of the stipule itself. But this increase in size is lost again in the tenth leaf and the reduction continues to final abortion. *Melilotus alba* Lam. presents very similar though somewhat less primitive conditions.

While considering leguminous plants, a few words concerning stipels, which are so characteristic of the family, would be in place. They have been denominated as "the stipules of leaflets," but I am convinced that they have no connection with stipules whatever, but that they represent rudimentary leaflets which have their origin in a tendency to increased compounding. The habit has become so fixed in the Leguminosæ that evidence of its origin is seldom met with. I have however seen, in *Lespedeza capitata* Michx., one of the earliest leaves with the terminal leaflet only developed and the two lateral ones represented by stipels.

I have found more light on the question in other families where the same tendency to increased compounding often occurs. In *Sanguisorba Canadensis* L. (fig. 47) for example, very vigorous plants sometimes show rudimentary leaflets, more developed indeed than typical stipels, but in the same position. Their character as leaflets of secondary rank is evinced by their occasional removal to a little distance from the primary petiole. A more striking case is that of *Sambucus Canadensis* L. In this species the leaves of young shoots springing up where the bushes have been cleared away are frequently partially bicompound and there are all gradations between the ordinary pinnate form and the bipinnate condition (figs. 48–50). In this case it is remarkable that the first appearance of the secondary leaflet is in the shape of a small body with both the form and position of a stipel, with the same small supporting vein and differing only in greater thickness. These facts seem to give evidence sufficiently conclusive that stipels are in reality rudimentary leaflets. That their development is not confined to the Leguminosæ is farther shown by their characteristic occurrence in *Staphylea trifolia* L.

Another frequent foliar variation among the Leguminosæ is the development of the phyllodium, which might be thought to have some connection with stipules, but the presence of both together in some genera disproves the idea.* The stipules in the Leguminosæ often take the form of spines which serve for the general protection of the plant. We have an example in the well known *Robinia Pseudacacia* L. (fig. 51). In some of the tropical Acacias, as for example *A. spadicigera* C. & S. (fig. 52), they take the form of enormous hollow horns which are appropriated as homes by some species of ants.†

Sambucus Canadensis L. presents another remarkable character. The leaves of the vernal shoots from subterranean buds are furnished with stipules of the same form and in the same position as those of *Sambucus Ebulus* L., but smaller. There are four of them at each node, they are ovate or nearly orbicular in form, small, rather fleshy and persist but a short time. Each is supplied with a small vascular bundle, originating as a branch of the nodal girdle which connects the leaf-traces. These facts give evidence of the close relationship of these two species of *Sambucus*, and of the characteristic presence of stipules in the ancestral form. In *Sambucus Ebulus* L., they are still typically developed, but in our species have become so far vestigial as to appear only in connection with the early leaves of shoots from subterranean buds, an additional evidence of the importance of the leaf-forms successively developed from such buds, in their bearing on the evolutionary development of modern adult forms.

If now we turn to the family of the Rosaceæ we shall find many illustrative examples of the same facts as those born out in the case of *Baptisia tinctoria* (L.) R. Br. But it frequently happens that basal degeneration does not take place or is only partial, re-

* Bentham and Mueller. Flora of Australia, 2: 304. 1864.

† Belt. Naturalist in Nicaraugua, 218. 1874.

sulting in the adnate stipules characteristic of so many genera and species of the family. *Agrimonia striata* Michx., in the development of its subterranean buds in the spring, presents an excellent series of embryonic leaf-forms. The lower ones are all simple sheathing scales completely surrounding the stem at their insertion. Not until the eleventh leaf (fig. 53), which is three-toothed at the apex, does the differentiation of parts begin. The central tooth is the beginning of the blade with its petiole; the lateral portions with their tips now free are the stipules. To say that they are "adnate" indicates only that they retain their primitive connection with the central-basal portion. In the twelfth leaf (fig. 54), there has been some basal degeneration, as shown by the lower point at which the three main bundles of the leaf converge and the lower position of the zigzag plexus of the stipular veins. The free tips, on the other hand, have increased in size and a small blade supported by a petiole is present in consequence of the development of the central tooth. The fifteenth leaf (fig. 55) shows a stronger development of all the parts, and a branch of the main stipular bundle is seen to pass up the petiole. The adult form is attained in the seventeenth leaf (fig. 56). In it some further basal degeneration has taken place, but the adnation of the stipules is still very prominent.

Prunus Cerasus L. gives a very good morphological series, but the venation is obscure. A view of the several forms can be had by an examination of the tenth, thirteenth, fifteenth, sixteenth and seventeenth leaves (figs. 57–61). They show the transition from the simple primitive scale to the mature condition in which the stipules are rendered entirely free. The series is similar in *Rubus occidentalis* L., *Pyrus Malus* L. and *Pyrus communis* L. In *Rubus villosus* Ait. (figs. 62–66), the basal degeneration is not carried quite so far and the stipules in the adult leaf-forms remain adnate for some distance from the base of the leaf. The tips of the stipules have taken a larger comparative development than in *Agrimonia*. Anatomically, however, *Rubus villosus* Ait. resembles the latter in having a vein which enters the petiole, neighboring to the main stipular bundle much as in *Viola obliqua* Hill (fig. 18). The venation in *Pyrus Malus* L. (fig. 67) is still more like that in *Agrimonia*.

The stipules of *Fragaria* and *Rosa* show the highest degree of adnation and little, if any, basal degeneration seems to have taken place, though the lateral leaf bundles curve in toward the median one at but a short distance from the stem. This arrangement of the bundles is probably secondary in these forms for the purpose of giving a firmer support to the leaf by an axial concentration of the vascular tissue in the sheath and a corresponding thickening of the surrounding tissues, a firmer support than could be given by only three bundles if they did not converge till they approached the point of their entering the petiole. The venation of the stipules is also peculiar. In *Fragaria Virginiana* Duchesne (fig. 68), there is a single strong bundle running out into the free tip of the stipule. From this are sent out one or two weak veins above, and below there is a faint vascular network confined mostly to the region of the tip and extending in a long curve toward the outer portion of the base, where it gradually fades out without forming any connection with other vascular tissue below. This condition seems to indicate a former basal connection of these stipular bundles, either with the lateral bundle of the leaf or possibly with those of the stem, forming an additional leaf-trace bundle distributed to the stipules only. The former case is far more likely. A probable explanation of this degeneration of the basal stipular bundles can be found by a consideration of the conditions of the environment. All the leaves being basal, the stipules are clustered together and are supported by one another and by the surrounding soil. They are more or less fleshy, destitute of chlorophyll, and in their moist surroundings loss of water by evaporation is comparatively slight. All these circumstances lessen the necessity of the supply of fresh sap. The rapidly conducting vascular tissue has come into disuse, and its degeneration and disappearance is the natural consequence. The same arrangement in forms with leafy stems is not so readily explainable except by the supposition that the arrangement is ancestral. This seems rather evident in the case of *Agrimonia striata* Michx. (figs. 53–56), where the same condition of the bundles occurs, for the earliest leaves representing the ancestral forms develop under the same conditions as the adult leaves of *Fragaria*. But in *Rosa* it would be by no means clear did we not have such intermediate types as *Agrimonia*. *Rosa humilis* Marsh. (fig. 69) may be taken as typical of the genus. The venation of the tip of the stipules is nearly like that in *Fragaria*, but with a little larger development above the main bundle. The vascular network below is much more extensive and is reënforced by several small branches from the lateral bundle which enters the petiole, below the main stipular branch. This additional supply of vascular tissue is evidently rendered necessary by the exposure of the stipules to the light and air and the development of chlorophyll. It seems to be of secondary introduction.

The nearest approach to the stipular conditions occurring in *Fragaria* and *Rosa* which I have observed among the Leguminosæ is found in the adnate stipules of *Trifolium pratense* L. (fig. 70). There are two sets of stipular bundles. One of these supplies the tip of the stipule and consists of three veins of which the lowest corresponds to the single large bundle of the tip of the stipules of *Fragaria* and *Rosa.* The other has its origin as branches from the lateral bundle of the leaf-trace at the base of the leaf, the usual point of origin of the veins of free stipules. This set of veins is distributed to the lateral and basal parts of the stipules and apparently corresponds to the lower network of the stipules in *Fragaria.* These stipules are mainly protective in function. Their meshes are filled with hyaline tissue, but there is some green parenchyma along the veins.

Two very interesting cases in the family of the Rosaceæ are those of *Cliffortia graminea* L. f. of South Africa (fig. 71) and *Potentilla fruticosa* L. (fig. 72). In the former the leaves very closely simulate those of grasses with the linear lamina sessile upon a sheathing petiole. They differ in having the tips of the lateral portions (stipules) free instead of turning in across the insertion of the lamina to form a ligule. In the latter the conditions are very closely similar to those of the ochrea of *Polygonum.* There is a short sheathing petiole, above the apex of which the tips of the stipules rise. Each of them is supported by a strong vein which has its origin at the base of the true petiole. But instead of being free from one another as in *Rosa*, the stipules are connected back of the petiole by a hyaline ligular tissue. The lateral portions of the sheathing petiole are also united to one another on the opposite side of the stem, at least in young leaves, to a considerable degree. Thus an ochrea is formed, not quite a typical one it is true, yet more nearly so than that of *Polygonum sagittatum* L. (fig. 32).

The fact that such forms as these can occur in the same family of plants along with typical stipules, both adnate and free, goes to show how small is the real difference between the various stipular forms. Not all stipules possess supporting tissues but, just as is the case in the ligule of most grasses, may be without any fibro-vascular bundles whatever. This is the case in *Vitis*, in *Parthenocissus* and *Hydrocotyle*. *Vitis Labrusca* L. (fig. 73) shows a somewhat thickened central streak at the base of the membranous stipule, but in *Hydrocotyle Americana* L. (fig. 74), the thickness is uniform and the stipule very thin. These facts give some authority to the supposition that the pectinate interpetiolar appendages which occur in the Composite *Willoughbya scandens* (L.) Kuntze (fig. 75) are true stipules. They are hyaline in texture, without supporting tissue, and may possibly be merely of epidermal origin. To determine this point requires opportunity to examine their development.

It is of importance to state that the tendril of the Cucurbitaceæ, regarded by many as a stipule, has been determined by anatomical examination to represent the first leaf of the axillary bud.* The spines of *Xanthium spinosum* L., simulating stipules in position, are degenerate pistillate flowers. As proof of this, they often bear a greater or less number of hooked prickles like those of the flowers, and there may be a spine on one side and a flower on the other, showing them to be of the same significance.†

The stipules of *Comptonia peregrina* (L.) Coulter (fig. 76) denied by some to be properly so-called, do not differ anatomically from other stipules notwithstanding their peculiar morphology, and are to be included under the term. One of the chief reasons for their exclusion seems to have been the absence of stipules in *Myrica*. This is doubtless a case parallel with that of *Viburnum*, of which most of the species have lost their stipules by degeneration.

While it is not a generally accepted view, there is no good reason why stipules should not sometimes be distinguishable in floral parts. They are clearly present in the sepals of *Rosa* and *Rhodotypus*, and the smaller intermediate lobes of the calyx of *Potentilla* probably represent pairs of united stipules, one from each neighboring calyx-lobe in the manner of interpetiolar stipules.‡ The teeth of the filament in *Deutzia* are very suggestive of stipules in

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*See Lestiboudois, Bull. Soc. Bot. Fr. 4: 746–747. 1857. Cited on p. 6.

† See also Clos. Mem. Acad. Sci. Toulouse, (IV), 6: 66–75. 1875.

‡ See Engler and Prantl. Pflanzen Familien. 3: Abt. 3, 6. 1894.

stamens, and the corona of *Silene* may very probably represent a ligule. The glands of the leaves of Ranunculaceæ which have been homologized with stipules, as already stated, can often be traced up into the flowers and are familiar in connection with the petals of *Ranunculus.*

One of the most interesting families of plants in the development of its stipules is that of the Rubiaceæ, the development being very unusual in the group of the Stellatæ. Though the foliar anomaly in this group was early remarked upon and was anatomically explained as early as 1840,* there are considerations which make its present discussion desirable.

In the greater part of the family the leaves are opposite, or occasionally in whorls of three as in *Cephalanthus occidentalis* L., and are usually stipulate. The stipules are of variable character and often interpetiolar, the adjoining stipules on each side of the stem being connate. In the group of the Stellatæ however, comprising ten or twelve genera, the stipules usually are apparently wanting and the leaves in whorls. There is a tendency toward a verticillate arrangement of the leaves in others of the Rubiaceæ, as shown by the frequent occurrence of whorls of three in usually opposite-leaved species. Now an anatomical examination of the whorled leaves of *Mollugo verticillata* L., *Silene stellata* (L.) Ait. f., *Leptandra Virginica* (L.) Nutt. and *Cephalanthus occidentalis* L. reveals the fact that in other families, as well as in the Rubiaceæ exclusive of the Stellatæ, each leaf of any whorl receives its fibro-vascular bundles directly from the cauline cylinder. But in *Galium* the case is different. Two leaves only of the whorl receive their bundles in the manner stated, and only these two produce buds in their axils. All the others receive their vascular supply from what may be termed a nodal girdle, each half of which is formed by the union of two bundles arising, one from each of the two leaf-traces in the same manner as those supplying stipules of the ordinary form. From this girdle arise the bundles which supply the additional leaves, whether there be only one on each side, as in *Galium circæzans* Michx. and *G. lanceolatum* Torr., two, as in *G. triflorum* Michx. and *G. tinctorium* L., or even three or four, as occurs in *G. Aparine* L. The distribution of the vascular bundles may be seen in a cross section of the node of *Galium tinctorium* L. (fig. 77).

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* See page 6.

This anatomical arrangement shows that the so-called additional leaves of the whorls in *Galium* are in reality stipules and that the Stellatæ agree with the rest of the Rubiaceæ in having opposite leaves. The tendency of the family however to produce verticillate leaves has been strongly felt in this group but has taken an unusual course, the increased assimilative area having been evolved through the stipules instead of by an increase in the number of true leaves. The explanation is thus made comparatively simple except in those cases where the number of stipules at a node is more than four.

As a general rule, in plants with stipulate leaves, each leaf is provided with two stipules. But when the leaves are opposite, the two on the same side of the node often coalesce, forming a single interpetiolar stipule, as in the case of *Cephalanthus* (fig. 78). That this coalescence is secondary is shown by the fact that the distal portions only of the veins of the two stipules have united. Now in the Stellatæ also, this must have been the original condition, but the interpetiolar stipules have been greatly developed to serve assimilative purposes, the veins having meanwhile united completely to form a midrib. The increase in size has advanced until in *Galium* the stipules are of the same size and form as the leaves and morphologically indistinguishable from them, except in *G. bifolium* where the stipules are smaller. In this condition they remain in the broader-leaved species, as *G. pilosum* Ait., *G. latifolium* Michx. and *G. lanceolatum* Torr. But in the narrower-leaved species, a still greater foliar expansion being desirable, separation has been re-accomplished, proceeding probably from the tip downward, as is illustrated in *Rubia peregrina* L. with whorls of four. In this species stipules are occasionally found with two midribs (fig. 79), most widely separated at the apex or even coalescing toward the base. In *Galium Aparine* L. and other species in which the number of stipules is abnormal, we may suppose this condition to have arisen from a repetition of the process of division which has produced the six-leaved whorls. This is not improbable, since even in the four-leaved forms the stipules have already entirely lost their original morphological character and have taken on a more generalized nature, making them fit material for development along new lines of evolution. Embryological evidence is not wholly wanting, although the family stands so near the head of the plant series. In

Galium Aparine L., in common with the six-leaved species, the earlier whorls are of four leaves only, representing the ancestral condition. In *Rubia tinctorium* L., the opposite leaves of the subterranean portion of the stem are exstipulate. At the first aërial node there is a whorl of four, interpetiolar stipules being present, and in the higher whorls there are six leaves.* This is a series of long range, though lacking in intermediate steps.

Another case in which there is present a nodal girdle from which the stipular bundles arise is that of *Humulus Lupulus* (fig. 80), but there are three bundles in each leaf-trace. They are placed at about equal distances around the circumference of the stem, and the girdle-bundles proper occupy only about one-third of the periphery on each side. From them a part of the stipular bundles arise, the remainder originating directly from the lateral bundles of the leaf-traces.

It would be to small purpose that examples should be further multiplied. From those already cited we may confidently deduce the following conclusions :

1. The sheathing petiole has its origin independently of the true petiole and is formed by a concomitant development of the lateral and central-basal portions of the primitive leaf.

2. The ligule is a special development of the apical parts of the lateral portions of the primitive leaf along the ridge between the sheathing petiole and the distal parts of the leaf. It may be supplied with veins either by the marginal bundles of the sheath or by tangential branches from those entering the blade. The sheathing petiole may disappear by degeneration, rendering the ligule axillary as in many species of *Potamogeton*.

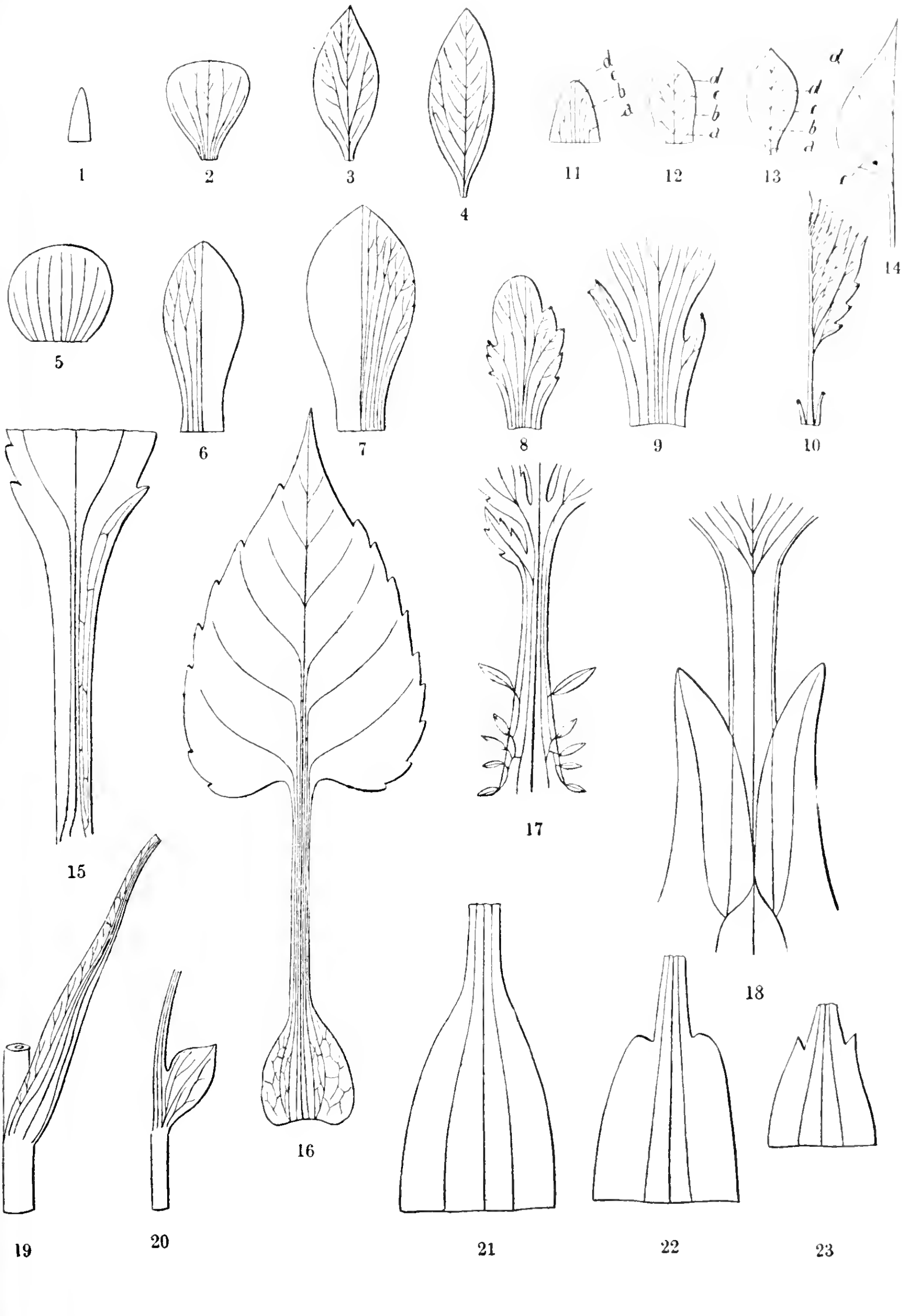
3. The ochrea is related to the ligule and is generally associated with the sheathing petiole. It consists of the apical tissues developed in those cases where the sheathing petiole completely surrounds the stem or did so in the ancestral condition. The part of the ochrea posterior to the lamina or petiole may be called its ligular portion and is usually supplied by bundles arising tangentially from the main ones.

4. The lateral portions of the primitive leaf, when separated in greater or less degree, constitute stipules in the usual acceptation of the term. They are variously modified by subsequent evolu-

*Sir John Lubbock. Jour. Lin. Soc. Lond. 30 : 504. 1894.

tionary changes, by increased development, by basal or total degeneration, by secondary adnations and various textural modifications. They receive their vascular bundles typically as branches of the lateral ones of the leaf-trace.

5. The lateral portions of the primitive leaf therefore represent in potential the ligule, the ochrea, the margins of sheathing petioles and stipules, but they are often incorporated with the other portions as the wings of petioles and as lateral basal portions of leaf-blades.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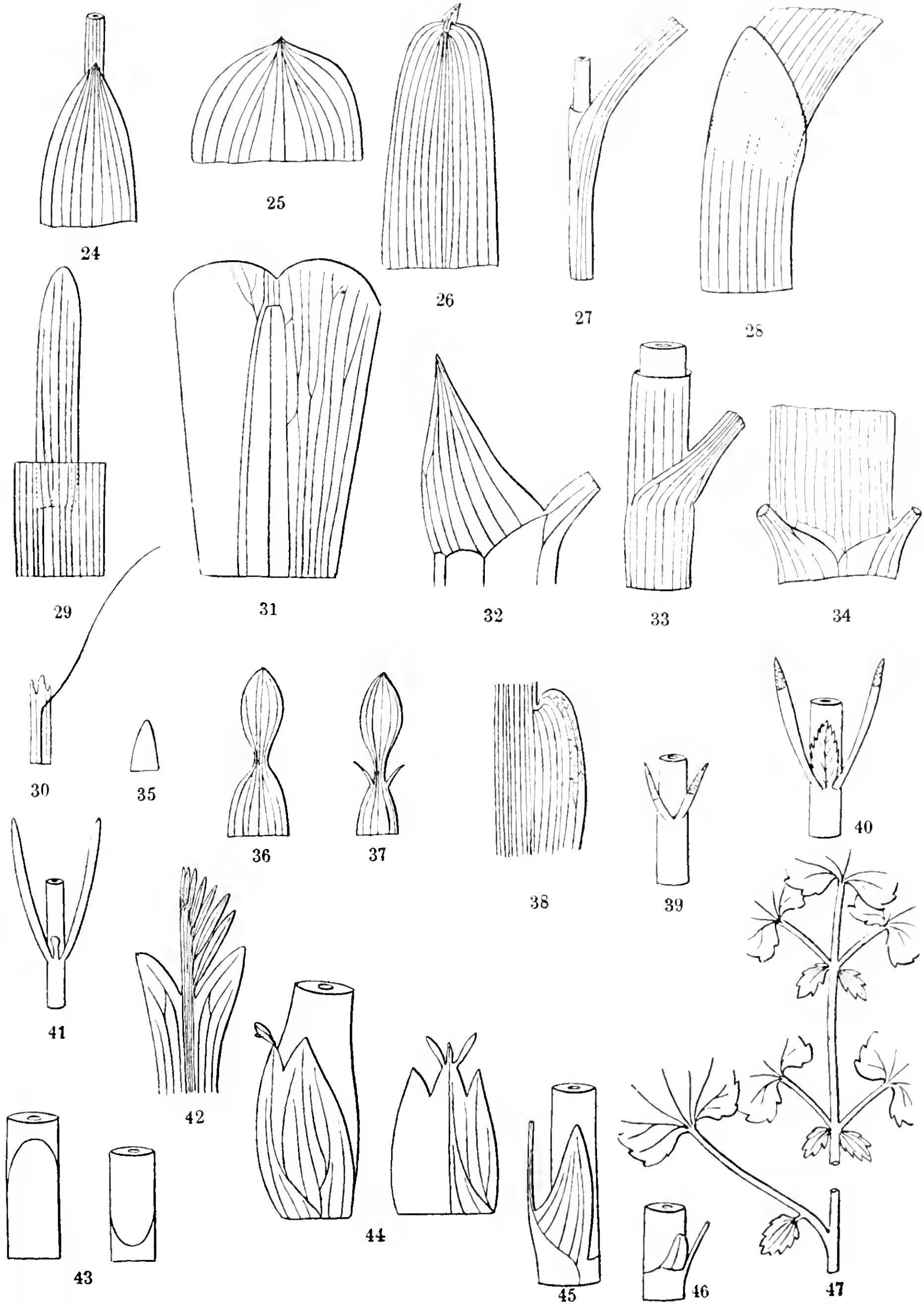

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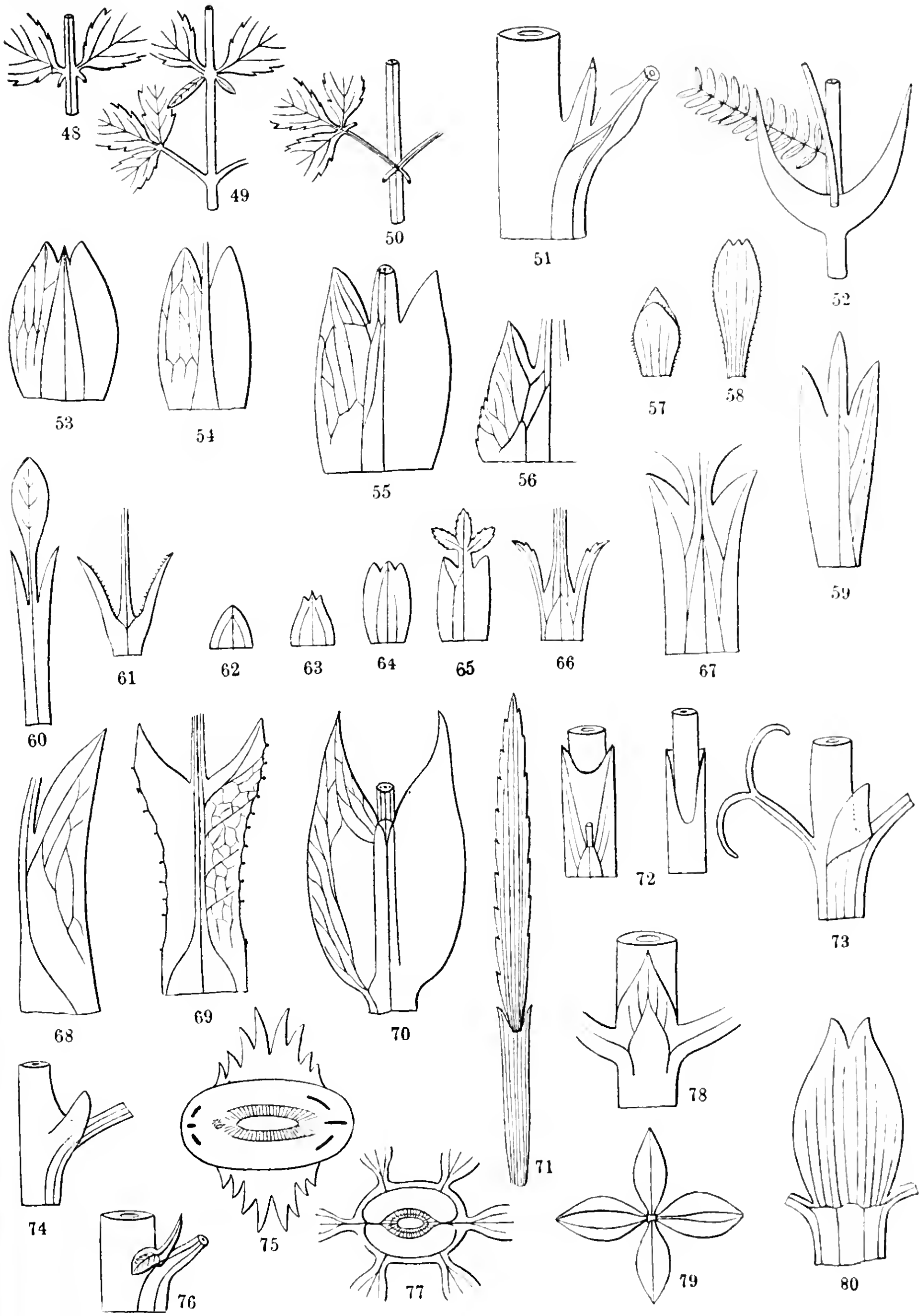
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CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 120.

Studies in the Botany of the Southeastern United States.—X.

BY JOHN K. SMALL.

[Reprinted from the BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 24, No. 5, May 29, 1897.]

Studies in the Botany of the Southeastern United States.—X.

By JOHN K. SMALL.

THE GENUS TRADESCANTIA IN THE SOUTHERN STATES.*

Six years' experience with *Tradescantia*, both in the field and in the herbarium, has convinced me that there is something fundamentally wrong in the several existing treatments of the genus. Since I became interested in the forms occurring in the Southern States Dr. J. N. Rose has arranged to monograph the North American Commelinaceae and I publish these notes with his knowledge and consent.

Linnaeus described a single North American species, namely, *T. Virginiana*.† Of American authors, Walter,‡ Michaux,§ Pursh,|| Elliott ¶ and Darby,** each described two species, while Chap-

* I have had the privilege of examining material in the herbaria of Lafayette College, through Professor Thos. C. Porter, and of Franklin and Marshall College, through Professor J. S. Stahr. Professor S. M. Tracy has sent me specimens at various times. I have also received material from regions beyond the area with which this paper is concerned, from Mr. B. F. Bush, Rev. E. J. Hill and Rev. J. M. Bates.

† Sp. Pl. 288.

‡ Fl. Car. 119.

§ Fl. Bor. Am. 119.

|| Fl. Am. Sept. 218.

¶ Bot. S. C. & Ga. 380–381.

** Bot. S. States, 547–548.

man* added a third, *Tradescantia pilosa.* With the exception of Walter all these authors used the same two specific names, applying Ventenat's *Tradescantia rosea* properly and making *Tradescantia Virginiana* elastic enough to embrace everything else savoring of *Tradescantia* that existed in their respective regions. Walter applied the name *Virginica* not to the Linnaean type, but to the form that Ventenat later described as *Tradescantia rosea* and proposed the name *cristata* for one of the larger forms which most authors thought was the real *Tradescantia Virginiana* of Linnaeus, but judging from Walter's description I am inclined to think he had in mind a later described species.

Rafinesque's work on the southern *Tradescantias* must needs be mentioned. This eccentric author described no less than twenty-six species and varieties in eastern North America, thus treating the genus from the standpoint of extreme segregation just as the authors mentioned above treated it from the standpoint of extreme aggregation. Rafinesque apparently founded a species on nearly every specimen he collected and of course his work needs extensive reduction, but to what previously described species to refer many of the Rafinesquian names is a difficult task. However, several of the forms he described, prove to be excellent species, for example, *Tradescantia brevicaulis* which Dr. Morong restored several years ago† and *Tradescantia reflexa* which I restore in this paper.

An attempt to segregate the material in an herbarium on the lines laid down in the several different works above referred to must at once prove futile and not until we recognize the several segregates into which the *Virginiana* type naturally separates itself can we hope for a clear or scientific interpretation of the group from a specific standpoint.

Key to the Species.

Umbel-like cymes peduncled, subtended by small or minute bracts.

Leaves ovate or ovate-lanceolate; sepals 2–3 mm. long. 1. *T. Floridana.*

Leaves linear or almost filiform; sepals 5–6 mm. long. 2. *T. rosea.*

Umbel like cymes sessile, subtended by large leaf like bracts.

Leaves linear or linear-lanceolate, 12–50 times longer than broad, more or less involute; plants glabrous, villous, hirsute or glandular.

* Fl. S. States, 498.

† Bull. Torr. Club, 20: 470.

Stems abbreviated, 1 to rarely 10 cm. long; bracts longer than the leaves.
3. *T. brevicaulis.*

Stems elongated, 20–100 cm. long; bracts shorter than the leaves.

Sheaths not imbricated at the base of the stem.

Stem glabrous; pubescence, when present on other organs, villous and silvery.

Plant bright green; pedicels 2.5–5 cm. long, villous; sepals 12–18 mm. long, villous, about twice as long as broad, becoming membranous. 4. *T. Virginiana.*

Plants glaucous; pedicels 2–2.5 cm. long, glabrous; sepals 8–10 mm. long, with a tuft of hairs at the apex, 3–4 times as long as broad, leathery. 5. *T. reflexa.*

Stem hirsute; pubescence brownish. 6. *T. hirsuticaulis.*

Sheaths imbricated for 5–20 cm. at the base of the stem.

Plant densely glandular; sepals linear-lanceolate or linear oblong, 1 cm. long. 7. *T. longifolia.*

Plant glabrous except the villous sheaths at the base of the stem; sepals ovate or oblong, 7 mm. long. 8. *T. foliosa.*

Leaves lanceolate or narrowly lanceolate, 4–10 times longer than broad, flat; plants glabrate, pilose or villous.

Stem clothed with long villous hairs. 9. *T. comata.*

Stems glabrous, or pilose.

Plant usually slender; stems mostly strict; umbels solitary and terminal or on corymbed branches; flowers 2–2.5 cm. broad; species Alleghenian. 10. *T. montana.*

Plant usually stout; stems mostly flexuous; umbels terminal and sessile in the upper axils; flowers 2.5–3 cm. broad; species campestrian.
11. *T. pilosa.*

1. Tradescantia Floridana S. Wats.

Tradescantia Floridana S.Wats. Proc. Am. Acad. 17: 381. 1882.

Perennial by creeping stems, slender, nearly glabrous, bright green. Stems procumbent, more or less matted, flaccid, 1–3 dm. long, rooting at the lower nodes; leaves ovate or ovate-lanceolate, 1–2 cm. long, thinnish, acute, ciliolate; sheaths funnelform, minutely roughened, fringed with long white cilia; cymes solitary or 2 together, terminal, their peduncles .5–1.5 cm. long, subtended by ovate or ovate-lanceolate bracts; pedicels filiform, 2–6 mm. long, villous and somewhat glandular; sepals ovate, about 2–3 mm. long, acutish, purple, pubescent; petals white; filaments glabrous; anther-cells contiguous; capsules oval, nearly 2 mm. long, glabrous.

Damp shady places, peninsular Florida: Miss Reynolds; Merritt's Island, A. H. Curtiss, 2995 (two collections under the one number); Sumpter county, J. D. Smith; Indian River, W. M. Canby.

2. TRADESCANTIA ROSEA Vent.

Tradescantia Virginica Walt. Fl. Car. 119. 1788. Not *T. Virginiana* L.

Tradescantia rosea Vent. Hort. Cels, *pl. 24*. 1800.

Perennial by rootstocks, slender, nearly glabrous, bright green. Stems erect or nearly so, often densely tufted, 1–5 dm. tall, usually simple; leaves narrowly linear or nearly filiform, 1–3 dm. long, flat or involutely folded, acuminate, sometimes surpassing the peduncles; sheaths cylindric or funnelform, .5–1 cm. long, fringed with long white cilia; cymes usually solitary, or sometimes 2 together, terminal, their peduncles 8–15 cm. long, subtended by linear bracts; pedicels 1–1.5 cm. long, glabrous; sepals lanceolate or ovate-lanceolate, 5–6 mm. long, acutish, petals pink or rose-color, orbicular-oblong, obtuse; filaments glabrous, anther-cells contiguous; capsules subglobose, 4–5 mm. in diameter.

Sandy soil, Maryland to Missouri, south to Florida and Texas. Spring and summer.

3. TRADESCANTIA BREVICAULIS Raf.

Tradescantia brevicaulis Raf. Atl. Journ. 150. 1832.

Tradescantia pumila Raf. New Fl. Part 2, 86. 1836.

Tradescantia Virginica var. *villosa* S. Wats.; Wats. & Coult. in A. Gray, Man. Ed. 6, 539. 1890.

Perennial by a cluster of slender roots, low, stoutish, more or less villous, bright green. Stems solitary or usually clustered, erect, almost wanting or 1–10 cm. tall, simple; leaves linear or narrowly linear, 1.5–3 dm. long, flattish, acute or sometimes rather obtuse, sheaths 1–2.5 cm. long, mostly imbricated; involucre of 2 nearly equal leaf-like bracts which are longer and broader than the leaves; pedicels stoutish, 3.5–5.5 cm. long, villous; flowers mostly purplish-blue, 5–15 in an umbel-like cyme, about 2 cm. broad; sepals ovate or oblong-ovate, 10–11 mm. long, obtuse; petals suborbicular, obtuse, delicately nerved; mature capsule not seen.

Hillsides and woods, Illinois to Missouri and Kentucky. May to June.

4. TRADESCANTIA VIRGINIANA L.

Tradescantia Virginiana L. Sp. Pl. 288. 1753.

Tradescantia rupestris Raf. Atl. Journ. 150. 1832.

Perennial by a cluster of rather thick white or yellowish roots, stout or stoutish, glabrous or nearly so, bright green. Stems usually clustered, erect, 2 dm. or mostly 3–4 dm. tall, nearly straight, simple; leaves linear or linear-lanceolate, 1 or usually 2–7 dm. long, acuminate, more or less curved, nearly flat or involutely folded; sheaths 1–3 cm. long, sometimes slightly ciliate; involucre of 2 lanceolate or linear-lanceolate nearly equal or very unequal leaf-like bracts which are usually much smaller than the leaves; flowers dark blue or purplish or rarely white, large, 3–4 cm. broad; pedicels 2.5–5 cm. long, sepals large, elliptic, ovate or ovate-lanceolate, 12–18 mm. long, obtuse or acutish, villous with long non-glandular hairs about twice as long as broad, becoming membranous; petals sub-orbicular, 1.4–2 cm. in diameter; capsule 5–7 mm. long, glabrous; seeds oblong, about 3 mm. long.

Hillsides and along streams, New York and Illinois, Virginia nd Arkansas. May–June.

5. TRADESCANTIA REFLEXA Raf.

? *Tradescantia canaliculata* Raf. Atl. Journ. 150. 1832.

Tradescantia reflexa Raf. New Fl. Part 2, 87. 1836.

Tradescantia reflexa var. *drepisia* Raf. New Fl. Part 2, 88. 1836.

Perennial by a rootstock and numerous rather delicate roots, slender or stout, glabrous, glaucous. Stems solitary, erect, 4–9 dm. tall, nearly straight, commonly much branched, sometimes purplish; leaves linear, 2–5 dm. long, straight, or somewhat curved, long attenuate; sheaths large, 1–3 cm. long, glabrous or rarely slightly villous; involucres of 2 unequal finally reflexed leaf-like bracts; flowers blue, or often red, 2–3 cm. broad, the umbel-like cymes at maturity usually dense; pedicels slender, 2–2.5 cm. long, crowded; sepals oblong or elliptic, apparently lanceolate by the involute edges, 8–10 mm. long, hooded, mostly with a tuft of hairs at the apex, sometimes glabrate, 3–4 times as long as broad, leathery; petals suborbicular; capsule ovoid or oblong, 5–6 mm. long, glabrous, constricted above the middle; seeds oblong, 3 mm. long, with irregular transverse ridges.

In sandy or clay soil, in the Gulf States and from South Carolina to Indian Territory and Texas; ascends the Mississippi Valley to Minnesota. May–August.

South Carolina: Elliott; Georgia: Small; Florida: Garber, Nash; Alabama: Earle and Underwood; Mississippi: Tracy; Texas: Drummond; Indian Territory: Palmer.

Conspicuous on account of its tall and proportionately slender habit, its narrow elongated leaves and usually very dense flower clusters. I have adopted the specific name *reflexa* of Rafinesque because the original description agrees very well with the specimens I have collected in the Southern States and the original locality lies within the bounds of the range shown by my specimens. The plant is usually glabrous except a more or less distinct tuft of hairs near the apex of the sepals.

6. Tradescantia hirsuticaulis n. sp.

Perennial by a cluster of coarse elongated (1–2.5 dm.) roots, slender, hirsute throughout with long brownish hairs, or partially glabrous above, otherwise bright green. Stems several together, erect or nearly so, 3–4 dm. tall, leafy throughout, densely hirsute, simple; leaves narrowly linear, 2–3 dm. long, more or less curved, involutely folded, less densely hirsute than the stem; sheaths rather pale, 1–2.5 cm. long, conspicuously ribbed; involucre of two linear very unequal leaf-like bracts which are somewhat smaller than the stem leaves; pedicels slender, 2–2.5 cm. long; flowers purple, large, 2.5–3 cm. broad; sepals variable in the same flower, ovate or lanceolate, 9–15 mm. long, rather villous and somewhat glandular; petals suborbicular, broader than long and undulate; mature capsule not seen.

Sandy places, Georgia to Florida; occurs at 400 meters on Stone Mountain. May to July.

Florida: Chapman, Wood; Georgia: Stone Mountain, Small. A very distinct and beautiful species related to *Tradescantia reflexa* but much more slender in habit. Remarkable for the abundant development of brownish hirsute pubescence on the stem, leaves and inflorescence. The flowers are larger and of a deeper blue than those of *Tradescantia reflexa.*

7. Tradescantia longifolia n. sp.

Perennial by a short rootstock and slender roots which are 1 dm. or rarely 2 dm. long; rather slender, glandular-pilose, dull green. Stems solitary, erect or assurgent, 4–5 dm. tall, strict, simple or sparingly branched above, densely glandular; leaves linear or nearly so, chiefly basal or confined to the lower part of the stem, 2–4 dm. long, even the lower ones surpassing or almost equalling the stem, gradually narrowed from near the base, flat, densely glandular-pilose like the stem; sheaths 2–2.5 cm. long, ciliate with long hairs, imbricated below; involucre of two small leaf-like bracts, or one often almost wanting; pedicels stoutish, 1.5–2 cm. long; flowers deep blue, 2.5–3 cm. broad; sepals linear-lanceolate or linear-oblong, 1 cm. long, obtuse, 1½ to 2 times shorter than the pedicels; filaments at length as long as the sepals, spirally twisted; capsule oblong, 8–9 mm. long, glandular-pilose; seeds oblong or ovoid, more or less flattened, gray, conspicuously marked with irregular transverse ridges.

Sandy soil in pine barrens, Florida: Curtiss, 2996 and 4680; Nash, 1574.

Many *Tradescantias* possess more or less glandular pubescence, but in this Floridian species, we find the whole plant covered with a short glandular pubescence which extends even to the petals. Its affinities are with *Tradescantia hirsuticaulis*, from which it differs primarily in the pubescence and the broader and elongated leaves which are chiefly confined to the base of the stem which they either surpass or nearly equal. The sepals are narrow and conspicuously elongated.

8. Tradescantia foliosa n. sp.

Perennial by a cluster of slender much elongated (more than 3 dm.) roots, rather stout, glabrous above, villous at the base, dull green. Stems solitary, erect, 4–7 dm. tall, simple or nearly so, very leafy near the base, glabrous or glabrate; leaves narrowly linear, 2–6 dm. long, nearly equalling or surpassing the stem, long-attenuate, crowded at the base; sheaths large, often densely villous, imbricated and sheathing the stem for 1–2 dm., prominently ribbed; involucre of 3 unequal leaf-like bracts; pedicels slender, 1–1.5 cm. long; flowers blue, about 2 cm. broad, the cymes at maturity dense; sepals ovate or oblong, about 7 mm. long, obtuse, two strongly hooded and with a tuft of hairs near the apex, one scarcely hooded and nearly glabrous at the apex; capsule oblong, 5–6 mm. long, glabrous; seeds irregular, 2–2.5 mm. long, not much longer than broad.

In clay soil, chiefly on hummocks, eastern and southern Florida: Keeler; Nash, 610 in part. May to June.

As in the case of *Tradescantia longifolia*, the leaves of this plant are crowded toward the base of the stem but they are much more numerous. The sheaths are loose, densely imbricated and villous, with very long delicate hairs. The upper part of the plant is apparently glaucous, the flowers are small, the sepals short and the fruiting calyx small and plump. The plant is destitute of glandular pubescence.

9. Tradescantia comata n. sp.

Perennial, stoutish, pubescent with long villous hairs. Stems erect or ascending, 3–5 dm. tall, simple or sparingly branched, very villous; leaves lanceolate or narrowly-lanceolate, 1–3 dm. long, acute or short-acuminate, ciliate, villous on both surfaces or glabrate above, somewhat narrowed near the base; sheaths villous like the stem, 1–3 cm. long; involucre of 1–2 bracts like the leaves but smaller; flowers blue, 1.5–2 cm. broad; pedicels usually densely villous; sepals oblong or elliptic-oblong, 7–9 mm. long, villous, acute or acutish; capsules oblong, 4–5 mm. long, glabrous; seeds oblong, 3 mm. long, tuberculate-ridged.

Upper districts and mountains of Georgia; Chapman, two collections.

Allied to *Tradescantia montana*, but readily distinguished by the conspicuous villous pubescence.

10. TRADESCANTIA MONTANA Shuttl.

Tradescantia montana Shuttl.; Britton, in Britton & Brown, Ill. Fl. 1: 377. 1896.

Perennial by a cluster of elongated roots, slender, nearly glabrous, dark green. Stems usually solitary, erect, 3–7 dm. tall, straight or nearly so, simple or sparingly branched above; leaves narrowly lanceolate or linear-lanceolate, 1–3 dm. long, usually minutely pubescent, or rarely glabrate, acuminate, flat; sheaths 1–2 cm. long, ciliate; involucre of two lanceolate leaf-like bracts, one of which is at least one-half smaller than the other; flowers blue, small, 2–2.5 cm. broad; pedicels slender, 1–1.2 cm. long; sepals ovate or oblong, sometimes apparently lanceolate by the involute edges, 5–6 mm. long, pilose or villous, obtuse, hooded, often minutely glandular; petals sub-orbicular or orbicular-ovate; capsule oblong or oval, 5–6 mm. long, glabrous, or pilose especially above the middle; seeds oval-oblong, 3 mm. long, irregularly tuberculate and coarsely granular.

Sandy hillsides in the Allegheny mountains from Virginia to North Carolina and South Carolina; ascends to 1200 meters in North Carolina. June to August.

Virginia: Britton, Small; North Carolina: Rugel, Porter, Small & Heller; South Carolina: Small.

Tradescantia montana appears to be strictly Alleghenian in its distribution. It is more closely related to *Tradescantia pilosa* than to any other species, but it is smaller throughout, with a straight or almost straight stem, narrower and thinner leaves and usually less pubescence.

Last July I found this plant abundantly on Paris mountain, near Greenville, South Carolina. It grew on the upper slopes and top of the mountain, chiefly in thickets. The species is apparently a late bloomer; although the season was far advanced the plants had not produced any capsules.

11. TRADESCANTIA PILOSA J. G. C. Lehm.

Tradescantia pilosa J. G. C. Lehm. Nov. Act. Leop. 14: Part 2, 822. *pl. 48.* 1828.

Tradescantia flexuosa Raf. Atl. Journ. 150. 1832.

Tradescantia axillaris Raf. New Fl. Part 2, 87. 1836.

Tradescantia axillaris var. *flexuosa* Raf. New Fl. Part 2, 87. 1836.

Tradescantia Virginica var. *flexuosa* S. Wats.; Wats & Coult. in A. Gray, Man. Ed. 6: 539. 1890.

Perennial, stout, pilose and more or less puberulent, dull green; stems erect or ascending, 4–8 dm. tall, flexuous, often puberulent, or glabrate, leafy to the top, simple or sparingly branched; leaves lanceolate or sometimes rather narrowly lanceolate, 1–2.5 dm. long, acuminate, dark green above, paler beneath; sheaths 1–1.5 cm. long, ciliate, inconspicuously ribbed; involucre of 2–3 bracts similar to the leaves, one about twice as long as the others; pedicels normally slender, 1.5–2 cm. long, villous-pilose, or often glabrate; flowers pale blue or deep blue, large, 2.5–3 cm. broad, the cymes usually crowded at maturity; sepals ovate or oblong, about 7 mm. long, apparently lanceolate by their involute edges, two strongly hooded, the third not hooded, mostly villous-pilose; petals ovate-orbicular, obtuse; capsule globose-oblong, 5 mm. long, constricted at the middle, pilose at the summit; seeds oblong or ovoid, 2–3 mm. long.

Thickets and shady hillsides, Ohio to Missouri, south to West Virginia and Tennessee. Naturalized about Bartram's Garden, Philadelphia. May to August.

In size, habit and leaf form, especially in the breadth of the leaves, this is our most conspicuous *Tradescantia*; the lanceolate leaves with their pilose pubescence, the normally flexuous stems and the usually axillary flower-clusters readily separate it from all other species. In range it is campestrian with Kentucky and Tennessee as its center of distribution; it is unknown west of the Mississippi river except in eastern Missouri.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 121.

Rarities from Montana. I., II., III.

Antennaria dioica and its North American Allies.

BY P. A. RYDBERG.

[Reprinted from the BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 24, No. 4, April 24, 1897; Vol. 24, No. 5, May 29, 1897, and Vol. 24, No. 6, June 29, 1897.]

Reprinted from the BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 24. No. 4, April 24, 1897.]

Rarities from Montana.—I.

BY P. A. RYDBERG.

(PLATES 300, 301.)

ALLIUM FIBROSUM n. sp.

Bulb with a fibrous coating; stem 2–3 dm. high, subterete, somewhat striate; leaves flat, thickish, 3 mm. wide, 1–1½ dm. long; umbel with numerous bulblets and few flowers on pedicels about 1 cm. long; perianth-segments lanceolate-oblong, obtuse, 6 mm. long; filaments slightly dilated below, ¼ shorter than the segments, and a little longer than the style; anthers oblong; ovary evidently 6 crested, with short rounded crests. (Plate 300.)

This somewhat resembles *A. Canadense*, from which it is distinguished by the smaller size, the bright red bulblets, and the crests of the ovary. From *A. reticulatum* and *A. Geyeri*, it is easily distinguished by the presence of the bulblets. Collected on a high dry mountain side near Lima, Mont., June 29, 1895, by P. A. Rydberg (no. 2606).

ALLIUM SIBIRICUM L. Mant. 562. 1767. (*Allium Schaenoprasum* β L. Sp. Pl. 301. 1753. *Allium Schaenoprasum* Authors.)

This has generally been confused with *Allium Schaenoprasum*, but it is evidently a good species. It is much taller than that plant, being generally 5–6 dm. high, has only one basal leaf and generally several stem-leaves, these thick, about 5 mm. in diameter, and broader perianth-segments. *Allium Schaenoprasum* is only 2–3 dm. high, and its base is surrounded by many narrow leaves.

In rocky places, Sweet Grass Cañon, Crazy Mountains. (Alt. 7000 ft., no 349.) It has also been collected at Deer Lodge, July 9, 1895, by myself (no. 2601).

CALOCHORTUS ACUMINATUS n. sp.

Stem about 2 dm high, with a secondary bulb in the axis of the first leaf; leaves 3–5 cm. long, very narrow and involute from a broader sheathing base; sepals narrowly lanceolate, scarious-margined, acuminate, equalling, or more often, exceeding the petals; petals white, rhombic, obovate or oval, acuminate, hairy at the base around the oval-oblong gland; filaments a little dilated, especially below; anthers linear, with slightly sagittate base, tapering a little upward, but not acute; stigma rather large and thick. (Plate 301.)

Dry Mountains, near Lima, P. A. Rydberg, no. 2600, Aug. 5, 1895.

It is apparently nearest related to *C. Nuttallii*, from which it differs by the longer sepals, longer and tapering anthers and the acuminate petals.

HABENARIA DILATATIFORMIS. (*Platenthera gracilis* Lindl. Gen. & Sp. Orch. 288. 1835–9. *Habenaria gracilis* S. Wats. Proc. Am. Acad. 12: 277. 1877. Not Hook. Exot. Fl. *pl. 135*. 1825.)

In general habit this most resembles *H. hyperborea*, from which it differs in the larger white flowers, in the lip, which is broadened at the base as in *H. dilatata*, although less so, and in the spur which is thickened at the end. From *H. dilatata* it differs in the less dilated lip and the shorter more saccate spur, which is slightly shorter than the lip.

Common in marshy places at an altitude of 5000–6000 feet. Spanish Basin by J. H. Flodman (nos. 360 and 361); also collected by P. A. Rydberg, in 1895, at Bozeman (no. 2607), and at Deer Lodge (no. 2608).

HABENARIA STRICTA (Lindl.). *Platentera stricta* Lindl. Gen. & Sp. Orch. 288. 1835–9.

This differs from the preceding in the greenish or purplish flowers, the narrower lip and the very short and much more saccate spur, which is scarcely more than one-half as long as the lip. *Habenaria saccata* Greene, Erythea, 3: 49, 1895, seems, from the description, to be the same. It is fairly common in swampy places of central Montana. Spanish Basin, collected by J. H. Flodman (no. 362), and by myself in 1895, near Mystic Lake, no. 2609.

ALNUS SINUATA (E. Regel).

Alnus viridis β Hook. Fl. Bor. Am. 2: 157. 1837.

Alnus viridis sinuata E. Regel in DC. Prod. 16: Part 2, 183. 1868.

Shrub 1-5 m. high; young bark brown and glossy with scattered white lenticles: older bark grayish; leaves 3–10 cm. long, oval, acute or acuminate at both ends, sinuately lobed and doubly and sharply serrate, thin, green and glabrous on both sides, very glutinous when young, in age shining; peduncles racemiform, very warty; staminate catkins 2 cm. long, sessile; pistillate ones shortly ellipsoid, 8–10 mm. long and 6–7 mm. in diameter, on pedicels 3–15 mm. long.

It most resembles *A. viridis*, but is easily distinguished by the thinner, more shining leaves, which are always more or less lobed and quite without any development of pubescence. In *A. viridis* the veins on the lower surface are more or less ferruginously puberulent. In the same species the pistillate catkins are generally over 1 cm. long. *A sinuata* has also been confounded with *A. tenuifolia* Nutt., which, according to Sargent, is an older name for *A. incana glauca* Regel or *A. incana virescens* Wats. I have not access to Nuttall's Sylva and am not able to verify this point. In the plate of *A. tenuifolia*, in the Silva of North America, the leaves resemble more the present species than *A. incana glauca*, but Prof. Sargent's description and synonymy belongs evidently to the latter. In *A. tenuifolia, i. e., A. incana glauca*, the leaves have much rounder lobes and less sharp dentations, are less acuminate, thicker, and generally somewhat pubescent on the veins. The pistillate catkins are, as a rule, nearly sessile on the common peduncle.

It is fairly common in the mountain regions of Montana. (Flodman, no. 369, Spanish Basin, July 10, 1896.) In the Columbia herbarium there are three specimens of this species, viz.: one collected by Mertens at Sitcha, one by Scouler (no. 59) from the Columbia, and one received from Hooker, but without any indication of collector or locality. Probably it was collected by Douglas.

Urtica cardiophylla n. sp.

Urtica dioica (?) Rydberg, Contr. Nat. Herb. 3: 179. 1895.

Stem about 1 m. high, angled and striate and, as well as the leaves, nearly devoid of bristles; leaves broadly cordate, or the upper somewhat narrower, 6–10 cm. long, coarsely toothed, very thin, dark green, perfectly glabrous and shining; petioles about 3 cm. long, very slender; flower clusters small, rather few-flowered, in the specimens seen scarcely more than half as long as the petioles; stipules linear-lanceolate, 5–10 mm. long, very thin.

On a wooded creek bank, near Castle, Montana, Aug. 1, 1896, J. H. Flodman, no. 370. A specimen was collected by the author near Whitman, Neb., in 1893. In the report it was doubtfully referred to *U. dioica* (Rydberg, no. 1790). It is evidently near *U. gracilis*, from which it differs in the broader thinner leaves, the smaller flower-clusters and the nearly complete absence of bristles.

Coriospermum villosum n. sp.

Stem 2–4 dm. high, much branched from near the base, the branches divergent, striate, when young with the leaves and bracts villous with many branched hairs, in age glabrate; leaves linear, 2–4 cm. long, 1–3 mm. wide, cuspidate-mucronate; spikes rather dense, with more or less imbricated bracts; lower bracts linear-lanceolate, 5–10 cm. long, the upper ovate-acuminate and cuspidate, 4–5 mm. long and about 3 mm. wide with broad scarious margin; achene 2–2½ mm. long and 2 mm. wide, acutely margined but scarcely at all winged.

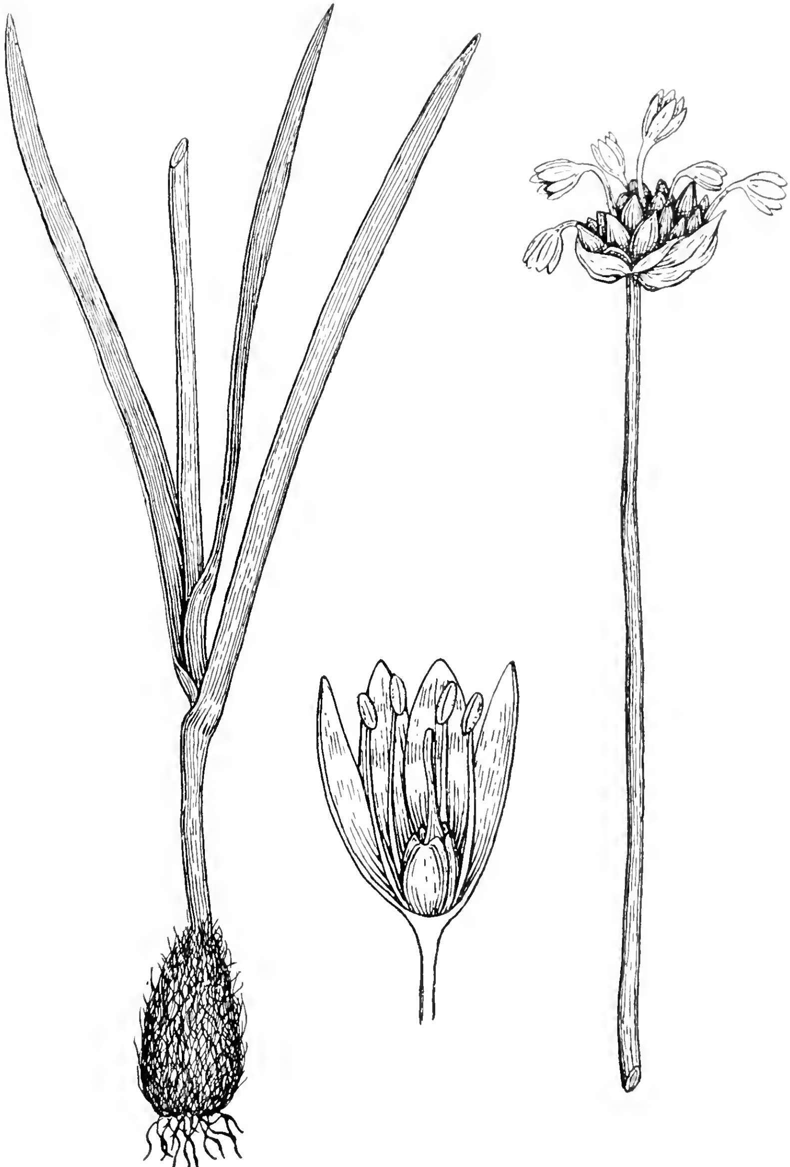
The following specimens belong to this species: *Montana:* P. A. Rydberg, no. 2623, 1895, from Manhattan, in flower. *Colorado:* Isabel Mulford, from Salida, in fruit. S. Watson, no. 993, from Carson Desert, Nevada, 1867, seems also to belong here.

There are at least three species of *Coriospermum* in the United States, viz.:

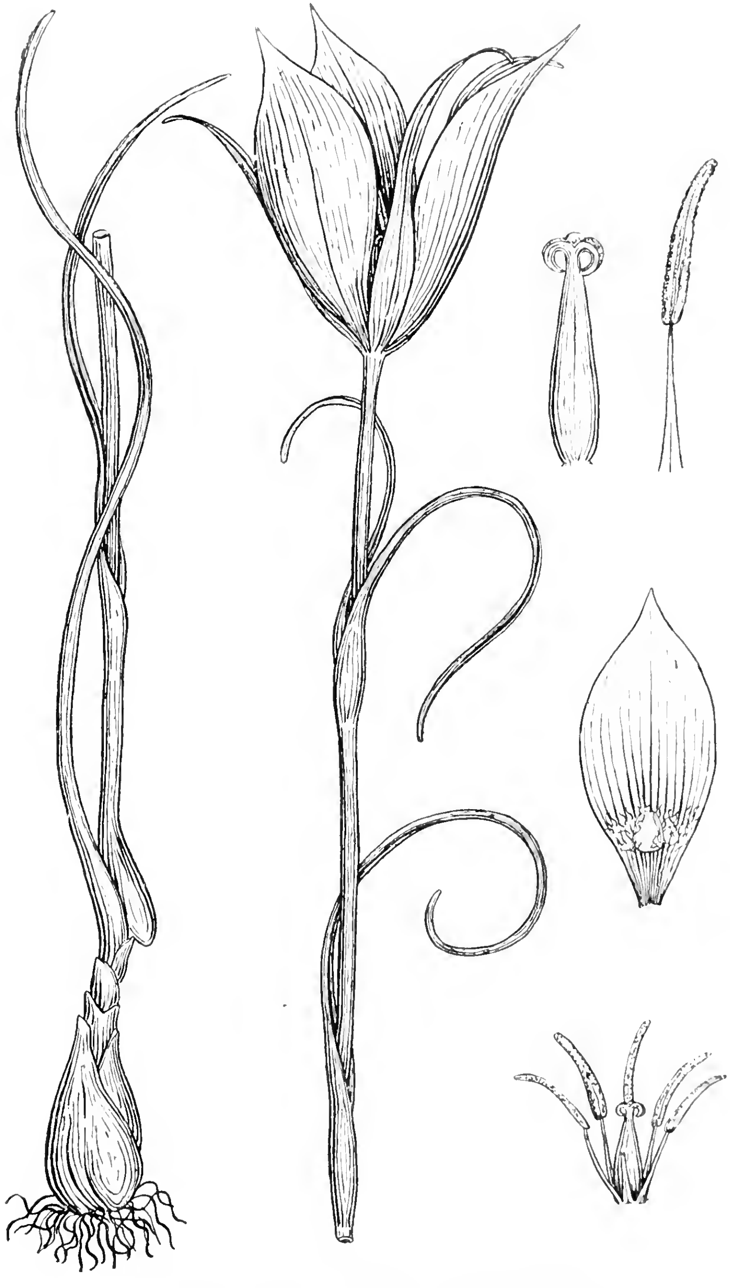
C. hyssopifolium L. with a low branching stem, more or less pubescent when young, very dense spikes with imbricated bracts, which are all broadly ovate, generally over 5 mm. long, and large achenes about 3½–5 mm. long and with broad wing margins It grows around the Great Lakes and northward to the Arctic and westward to Washington.

C. nitidum Kit (*C. hyssopifolium microcarpum* Wats.), with tall slender perfectly glabrous stem, ascending branches, lax spikes, whose bracts are not overlapping each other and are much narrower and shorter, 3–4 mm. long and generally narrower than the small, 2 mm. long, broadly winged achenes. I have compared the American form with the European and cannot find any character by which to separate it. It grows from Texas, Kansas, Nebraska to Arizona and Washington (?).

C. villosum, described above, which resembles *C. hissopifolium* in the spikes and the low branching, and *C. nitidum* in the size of bracts and achenes and narrow leaves, but differs from both by the lack of the wing margin and by the longer pubescence.



ALLIUM FIBROSUM RYDBERG.



CALOCHORTUS ACUMINATUS RYDBERG.

[Reprinted from The Bulletin of the Torrey Botanical Club, Vol. 24, No. 5, May, 1897.]

Rarieties from Montana.—II.

By P. A. Rydberg.

(Plates 304–307.)

Polygonum Austinae Greene, Bull. Cal. Acad. 2: 212. 1885.*

This little interesting *Polygonum* was collected on the side of one of the highest peaks of the Crazy Mountains, September 8, 1896, at an altitude of 8000 feet.

Polygonum Engelmannii Greene, Bull. Cal. Acad. 1: 126. 1884.

This has hitherto only been collected in the higher mountains of Colorado. It is not uncommon in central Montana at an altitude of 6000 feet or more. Cottonwood Creek, July 30, 1896,

* This and the next have been determined by J. K. Small.

Flodman, no. 400. Sweet Grass Cañon, Crazy Mountains, September 8th, no. 399.

Silene repens Patrin, in Pers. Syn. 1 : 500. 1805.

This Siberian species has been collected in Montana at the following stations: Spanish Basin, July 11, 1896, Flodman, no. 412; Mystic Lake, Bozeman Cañon, July 24, 1895, Rydberg, no. 2635. As far as I can find, there is no reference in print regarding its occurrence in America. Dr. B. L. Robinson, to whom the specimens were sent for identification and who has determined it as well as the next following species, writes:

"Your specimens of *S. repens* are very interesting. I have seen specimens from Alaska, but never before from other parts of North America. I have no doubt, however, of the identity of your plants with the real Asiatic plant, having just made careful dissections of the two alongside of each other. However, the matter of distribution is not so surprising after the discovery of *Stellaria dichotoma* in Montana some years ago."

Alsine calycantha (Ledeb.)

Arenaria calycantha Ledeb. Mem. Acad. St. Petersb. 5 : 534. 1812.

Stellaria calycantha Bong. Veg. Ins. Sitcha, 127. 1831.

This species was collected in a damp place just below a little patch of snow near the top of Yogo Baldy in the Little Belt Mountains, August 24, 1896, Flodman, no. 432.

Alsine longipes Edwardsii R. Br.

Stellaria Edwardsii R. Br., Parry's 1st Voy. 271.

This is, I think, the first time this variety is reported from within the United States. Only a few specimens were collected, at an altitude of 8000 feet on Spanish Peaks, July 14, 1896, Flodman, no. 429.

Arenaria subcongesta (Wats.)

Arenaria Fendleri subcongesta Wats. Bot. King's Exp. 40. 1871.

A. congesta subcongesta Wats. Bot. Cal. 1 : 69. 1876.

Arenaria congesta subcongesta as generally understood, I think, contains more than one distinct type; at least, that is the case with the material in the Columbia herbarium. The form represented by Watson's original from the King Expedition and the common plant of Montana, I think, is perfectly distinct from both *A. Fendleri* and *A. congesta*, and the relationship is rather with *A. capillaris.* Depauperate specimens of *A. subcongesta* resemble strikingly *A. capillaris nardifolia.* It differs, however, in the scarious bracts and the more acute sepals, which are nearly as broad as in *A. capillaris.* It surprises me that it ever could have been made a variety of *A. Fendleri*, which has very narrowly lanceolate attenuate sepals. I do not see any reason for uniting it with *A. congesta*, which has lanceolate, decidedly carinate sepals and headlike inflorescence, while in *A. subcongesta* the sepals are ovate rather than lanceolate, are not carinate, but three-nerved, and the inflorescence is open. As stated before, it comes in every respect nearer to *A. capillaris*, but I think it has just as good right to specific rank as any of the species mentioned.

A. subcongesta is common in central and southwestern Montana. Flodman, nos. 433 to 438, Rydberg, 2642, etc.

AQUILEGIA JONESII Parry, Am. Nat. **8**: 211. 1874.

This rare little columbine was collected in fruit on a mountain top near the Neihart Pass in the Little Belt Mountains, August 10, 1896, Flodman, no. 451.

ATRAGENE TENUILOBA (Gray) Britton, Bull. Herb. Boiss. 3: 206. 1895.

Clematis alpina var. *occidentalis* subvar. *tenuiloba* A. Gray in Newton & Jenney, Rep. Geol. Black Hills, 531. 1880.

Clematis Pseudoatragene var. *subtriternata* Kuntze, Verh. Bot. Ver. Prov. Brand. : 160. 1884.

This species has been reported hitherto only from the Black Hills and Colorado Mountains. In the Little Belt Mountains near Neihart Pass, at an altitude of 7000 ft., Aug. 10, 1896, Flodman no. 467; also near Helena in 1895, Rydberg, no. 2652.

RANUNCULUS SABINI R. Br. in Parry's 1st Voy. App. 264.

Specimens collected near the snow on Long Baldy, altitude 8000 ft. in the Little Belt Mountains, agree fully with the description of R. Brown's species. It is not to be referred to *R. pyg-*

macus, neither does Brown's description, especially that of the flower, agree with that species. Flodman, no. 469.

RANUNCULUS SUKSDORFII Gray, Proc. Am. Acad. 21: 371.

The range of this species is much extended eastward by its discovery on the Spanish Peaks at an altitude of 8000 ft., July 14, 1896, Flodman, no. 471.

RANUNCULUS SUBAFFINIS (Gray).

R. Arizonicus subaffinis Gray, Proc. Am. Acad. **21**: 370. 1886.
R. subsagittatus subaffinis Greene, Pittonia, **2**: 110 1890.

The author agrees fully with Prof. Greene that both the varieties of *R. Arizonicus* ought to be removed from that species, but is inclined to believe that *subaffinis* is specifically distinct from *subsagittatus*. I have seen Prof. Greene's specimens from the San Francisco Mountains, as well as others collected by Dr. Mearns and by Mr. Wooton in the same region; Flodman's no. 472, from the Bridger Mountains, July 28, 1896, agrees in every respect with them.

CARDAMINE UNIJUGA n. sp.

Stem from a very slender rootstock, slender, glabrous, simple, strict, 2–3 dm. high; basal leaves simple, about ½ cm. in diameter, broadly cordate or reniform in outline, round-sinuately 3-lobed; lower stem leaves with a pair of oblong leaflets below the terminal one, which resembles the basal leaves or is a little more rhomboid in outline; upper leaves similar but with all the leaflets oblong; raceme slender and narrow; flowers about 2 mm. in length, white; sepals ovate, obtuse; fruiting pedicels about 1 dm. long, nearly erect; silique erect, 15–18 mm. long and about 1 mm. wide, with a short thick style and 8–12 seeds. (Plate 304.)

The inflorescence and the silique much resemble those of *C. oligosperma*, but the plant is more slender and simple and the leaves in all specimens seen have only one pair of leaflets and the basal ones are simple, while in *C. oligosperma* the basal and lower stem leaves have 3–5 pairs. Spanish Basin, July 18, 1896, Flodman, no. 494.

CARDAMINE LEIBERGII Holz. Cont. U. S. Nat. Herb. 3: 212. 1895.

This species was rediscovered by myself in 1895, but only a few specimens were preserved. It was growing in cañons at two widely separated stations, viz., near Lima, in Beaverhead County, no. 2663, and in Bozeman Cañon in Gallatin County, no. 2664. It resembles a depauperate *C. Breweri*, but differs in the much thicker and more angular toothed leaves. The latter species is very common in Montana.

LESQUERELLA ALPINA (Nutt.) Wats. Proc. Am. Acad. 23: 254 1888.

Vesicaria alpina Nutt; T. & G. Fl. N. Am. 1: 102. 1838.

The true *L. alpina* has been found by me at the following stations: Lima, no. 2666; Melrose, no. 2667, both in 1895. Most of the specimens named *L. alpina* in the herbaria belong to *L. spathulata* Rydberg.

DRABA DENSIFOLIA Nutt.; Torr. & Gray, Fl. N. Am. 1: 104. 1838.

D. glacialis var. *pectinata* Wats. Proc. Am. Acad. 23: 260.

It is very doubtful if this is a variety of *D. glacialis*. The more tufted habit, the more flattened, more hairy and few- (4–6) seeded pod may well give it the rank of a species. Under all circumstances the name *densifolia* is much older than Watson's name and should not be suppressed. Mr. Flodman's specimens from the Little Elk Mountains, Aug. 10, 1895, no. 499, are nearly identical with Nuttall's type in the Torrey herbarium. It was also collected by the author at Silver Bow in 1895, no. 2669.

DRABA OLIGOSPERMA Hook. Fl. Bor. Am. 1: 51. 1830.

This has been merged into *D. glacialis*, and yet has still more right to a specific rank. It has a very slender flowering and fruiting stem, much smaller leaves, and a pod that is not half the size and with only 2–4 seeds. It was collected growing with the preceding. Flodman, no. 488. Also collected by the author on a mountain near Lima in 1895, no. 2668.

THEROFON HEUCHERAEFORME.

Saxifraga Jamesii Hook. Fl. Bor. Am. 1: 47. 1833. Not Torr.

Caespitose with a thick scaly caudex, glandular-hirsute, 1–2 dm. high; basal leaves round-reniform, deeply and often doubly crenate, on petioles about ½ dm. long; raceme simple or somewhat compound; calyx campanulate or turbinate, tinged with purple; sepals ovate, erect; petals obovate-oblanceolate or oblong-spatulate, dark violet, about equalling the sepals; stamens 10; styles free. (Plate 305, fig. 3.)

This has generally been confused with *T. Jamesii*, which it much resembles in habit. The main characters that distinguish the two are: in *T. heucheraeforme* the petals are dark bluish violet, scarcely exceeding the sepals and comparatively narrow, and the styles free (see plate 305, fig. 3); in *T. Jamesii* the petals are reddish purple, orbicular on a long claw, and often twice as long as the sepals, and the styles are united to near the top (see fig. 4). Both have 10 stamens, and differ in that respect as well as in habit from the other species of *Therofon*. In habit they much more resemble *Heuchera*. They may constitute a fairly good genus; but the arctic *T. Richardsonii* seems to connect them with the other species with 5 stamens, small white flowers and diffuse panicles.

T. heucheraeforme extends from the Black Hills of South Dakota to the Teton range of Wyoming and northward. The following specimens from Montana have been seen: Flodman, no. 514, July 28, 1896, from Bridger Mountains; P. A. Rydberg, no. 2677, July 23, 1895, from Bozeman Cañon; Frank Tweedy, no. 255, 1887, from East Boulder. *T. Jamesii* (Torr.) Wheelock, is as far as I know, confined to the alpine peaks of Colorado.

Mitella violacea n. sp.

Stem from a perennial rootstock, slender, about 3 dm. high, leafless, finely puberulent and with a few long silky hairs. Basal leaves on petioles 5–10 cm. long, the blade and petiole sparingly hispid, broadly cordate in outline, slightly 5–7-lobed with rounded finely crenate lobes; raceme very short with small nearly sessile flowers; flowers about 2 mm. in diameter; sepals ovate, rather obtuse, very thin and petal-like, veined and tinged with violet; petals oblanceolate, entire or slightly 3-cleft, a little exceeding the sepals (Plate 305, figs. 1–2).

In the form of the flower this stands nearest to *M. diversifolia* Greene. The sepals and petals are of the same size and form, but the former are generally tinged with violet and the latter less deeply 3-toothed, or entire. The leaves are broader and rounder in outline, the lobes shallower and rounder and evidently crenate. In other words the leaves are almost identical with those of *M. pentandra* Hook., from which the plant is easily distinguished by the small, nearly sessile flowers and the form of the petals. With

M. trifida, which also has 3-cleft petals, it can scarcely be confused, as that species has reniform leaves, larger flowers, and the segments of the petals are filiform.

Type: J. H. Flodman, no. 527, Spanish Basin in the Madison Range, Montana, July, 11, 1896, altitude 6000 ft.

POTENTILLA CANDIDA Rydberg, Bull. Torr. Club, **24**: 6. 1896.

A few specimens of this species were collected by me in 1895, at Deer Lodge, no. 2688, and at Lima, no. 2687.

POTENTILLA CONVALLARIA n. sp.

Stem tall, erect, 4–10 dm. high, long-villous but not very dyensel so, glandular or viscid, especially above, branched above with long erect branches. Stipules ovate or lanceolate, more or less toothed, about 1 cm. long; basal leaves several, with villous petioles 5–10 cm. long, pinnate of 4–5 pairs, glabrate or slightly pubescent; leaflets 2–5 cm. long, broadly obovate and obtuse, coarsely serrate and incised with ovate teeth; stem leaves with fewer more acutish leaflets; cyme with rather elongated upright branches, but with short pedicels, and therefore rather elongated and narrow; flowers 10–18 mm. in diameter; calyx densely glandular-viscid, villous, not much enlarged in fruit, 8–10 mm. in diameter; petals broadly obovate, white, in drying turning yellow, a little longer than the sepals; bractlets lanceolate, much smaller than the ovate-lanceolate sepals; stamens about 25, anthers flat, slightly cordate at the base. (Plate 306.)

This species resembles *P. arguta*, but is more slender. The branches of the cyme are rather elongated, the calyx smaller, the stamens fewer and the leaflets rounder and nearly glabrous. The leaves most resemble those of *P. glutinosa*, from which the plant differs mostly in its smaller and white petals and in the narrow cyme. It has been labelled *Potentilla arguta* whenever collected. It is apparently a rather rare plant, representing that species in the valleys of the northern Rockies. The following specimens have been examined:

Montana: Rydberg and J. H. Flodman, no. 602, in the Elk Mountains; no. 603 in the Spanish Basin; no. 604 (type) near Bozeman; no. 605 in the Bridger Mountains, all in 1896. F. L. Scribner, no. 42, 1883.

Washington: Wilkes Exp. no. 817; C. V. Piper, no. 1528.

Assiniboia: J. Macoun, no. 41, 1880. (?)

Idaho: A. A. & Gertrude Heller, no. 3230, 1896.

Wyoming: T. H. Burglehaus, 1894; E. Stevenson, no. 72, 1894.

Alberta (?): Macoun, no. 623, 1885 (Kananaskis).

POTENTILLA PSEUDORUPESTRIS n. sp.

(?) *Potentilla rupestris* Presl, Epim. Bot. 198. 1849. Not L.

Potentilla glandulosa Nevadensis Wats. Bot. Cal. 1: 178. In part. 1876. Not *P. Nevadensis* Boiss.

Stem erect, slender, striate, 2–5 dm. high, branched, with slender ascending branches, sparingly glandular-villous. Stipules ovate, more or less toothed. Basal leaves several on rather short petioles, pinnate with 3–4 pairs, sparingly and finely pubescent or glabrate; terminal leaflet obovate-cuneate-flabelliform, the lateral ones obliquely elliptical or nearly orbicular, all coarsely serrate and incised with ovate mucronulate teeth; stem leaves generally few, 2-paired or ternate with more rhomboid leaflets; cyme open, with ascending branches and slender pedicels; flowers 15–20 mm. in diameter; calyx more or less glandular-viscid, villous, in fruit not much enlarged, 8–10 mm. in diameter; petals white, drying yellowish, broadly obovate, exceeding the sepals by ⅓; bractlets oblong or lanceolate, much shorter than the ovate lanceolate pointed sepals; stamens about 25; anthers flat, a little cordate at the base. (Plate 307.)

This species is exceedingly similar to the European *P. rupestris*, from which it differs only in the smoother leaves and the longer pubescence of the stem. It differs from the other white-flowered American species in the open cyme, the slender pedicels and the larger petals, which nearly equal in size those of *fissa* and *glutinosa*. It grows in the mountains at an altitude of 2000 to 3000 m. The form growing at lower elevations is more leafy, with larger and glabrate leaflets and less viscid stem; this I took for *P. lactea* Greene, but Professor Greene has assured me that it is not that plant. In alpine regions it is more glandular viscid and with smaller leaflets. The following specimens have been examined:

Montana: Rydberg and J. H. Flodman, Long Baldy, Little Belt Mountains, no. 598 (type); Yogo Baldy, no. 499: Spanish Basin, nos. 597 and 600; Little Belt Mountains, no. 601 (altitudes, 6–8000 feet); R. S. Williams, no. 754, 1888.

Idaho: B. W. Evermann, no. 363, 1895; J. H. Sandberg, no. 164, 1888; J. B. Leiberg, 1890.

California: W. H. Brewer, no. 1714, 1863; Kellogg & Harford, no. 211, 1868–9.

Washington: W. H. Suksdorf, 1885.

Yellowstone National Park: T. H. Burglehaus, 1893.

Rocky Mountains of British America: Dawson, nos. 7471, 7870, 18734, 1430, 1881; J. Macoun, no. 10474, 1895.

SPIRAEA DENSIFLORA Nutt.; T. & G. Fl. N. Am. 1: 414. 1840. Under *S. betulaefolia.*

S. chamaedrifolia β Hook. & Arn. Bot. Beechy, 123. 1841.

S. betulaefolia rosea in herb., not Gray.

This seems to be well distinct from *S. lucida*, which is common in the same region. The latter grows mostly in open places, while *S. densiflora* is found only in the deeper woods. Bridger Mountains, Flodman, no. 543, and Little Belt Mountains, no. 544. The following specimens also are in the Columbia Herbarium: Nuttall (type) Rocky Mountains of Columbia; Beechey's Voyage, Kotzebue's Sound; J. M. Macoun, British Columbia, 1890.

HEDYSARUM SULPHURESCENS.

H. flavescens Coulter & Fisher, Bot. Gaz. 18: 300. 1893. Not Regel & Schmalh.

This was collected by J. H. Flodman in 1896 in the Spanish Basin, no. 650, and in the Bridger Mountains, no. 651, and by the author in 1895 near Bozeman, no. 2720.

TRIFOLIUM HAYDENII Porter in Hayden's Surv. 1871: 480. 1871.

This was referred to *T. Kingii* by Watson, but has nothing to do with it. It is rather common in certain localities of central and southwestern Montana. Flodman, no. 623, from the Bridger Mountains, and no. 624, from the Spanish Peaks; Frank Tweedy, Park Co., Montana, 1887, and in the Yellowstone Nat. Park, 1884. Also collected by the author and T. A. Williams in the Spanish Basin.

VACCINIUM MICROPHYLLUM (Hook.)

V. Myrtillus var. *microphyllum* Hook. Fl. Bor. Am. 2: 33. 1834.

In my opinion this is just as good a species as any, differing from

V. Myrtillus in the bright green branches, the small leaves, which are more pointed and scarcely half the size of those of that species, in the smaller nearly sessile flowers and the small bright red berries, which become dark purple only when fully ripe, never bluish black as in *V. Myrtillus.* It is common in Montana and was collected by Flodman in the Spanish Basin, no. 712.

GENTIANA CALYCOSA MONTICOLA.

G. calycosa stricta Griseb. Gen. & Sp. Gent. 292. 1839. Not *G. stricta* Willd., nor Klotzsch.

This beautiful little gentian was collected on the top of Yogo Baldy in the Little Belt Mountains, Aug. 24, 1896, Flodman, no. 726.

POLEMONIUM VISCOSUM Nutt. Journ. Acad. Phil. (II.) **1**: 154. 1847. Not Gray.

In describing *P. viscosum*, Gray* states that it has rounded calyx-lobes, and gives as reference: Pl. Gamb. 154 mainly, excluding what relates to the " elongated lanceolate segments of the calyx." The *Plantae Gambelii* were published in the Journal above cited. Nuttall describes there the calyx-segments as being elongated lanceolate, both in the Latin description and in the general notes written in English. In order to settle the matter I have written to the Curator of the Philadelphia Academy of Sciences, Mr. Stewardson Brown, who has kindly loaned me Nuttall's type. This is not a very good specimen, is past blooming, but it is satisfactory for my purpose. It shows that the inflorescence was subcapitate or subspicate and that the calyx-segments were elongated lanceolate. On the same sheet as Nuttall's type there is another specimen collected by T. S. Brandegee in the state of Washington; under the two specimens is penciled in the handwriting of the late Mr. Redfield the following remarks: " These all seem quite different from *P. confertum* in the flowers and mode of flowering. Yet I cannot fit them to Gray's description of what he regards as Nuttall's *P. viscosum.*"

From the more complete material I have at hand, viz.: specimens collected by J. H. Flodman, no. 742, August 19, 1896, on

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* Syn. Fl. **2**: part **1**, 150.

the top of Long Baldy, Little Belt Mountains, and by Frank Tweedy, 1887, in Park County, Montana, I can easily see that *P. viscosum* Nutt. is a near relative to *P. confertum* Gray. It has the same general habit and inflorescence. The corolla is, however, shorter, more open-funnelform and dark blue and the segments of the leaves are much smaller and rounder. The plant is very strong scented.

What Dr. Gray regarded as *P. viscosum*, I think I know, as there is a specimen in the Torrey herbarium, received from Dr. Gray and labelled in his handwriting. This specimen agrees also fully with Dr. Gray's description. It should be known under the name

POLEMONIUM PARVIFOLIUM Nutt. mss.

P. Mexicanum Nutt. Journ. Acad. Phil. 7: 41. 1834. Not Cerv.

P. viscosum Gray, Proc. Am. Acad. 7: 280. Not Nutt.

I have also examined Nuttall's type of *P. Mexicanum* collected by Wyeth, on the Flathead River. It differs from Gray's *P. viscosum* in no respect except that the calyx-lobes are a little longer. Nuttall himself has changed the name on the label to *parvifolium* probably because he had found that the name *P. Mexicanum* had been used before. That Gray had seen this specimen can be seen from a postal card from him, pasted on the same sheet, dated January 6, 1880, and on this, he states that he regarded it as being near *P. pumilum* var. *pulchellum*, and adds: "If I had to do it over, I would add a var. *parvifolium* to it." As *P. Mexicanum* and *P. parvifolium* are both based on the same specimens it is strange to find that Dr. Gray in 1886,* makes the following remark under *P. foliosissimum*. "To this probably belongs *P. Mexicanum* Nutt. Journ. Acad. Philad. 7: 41, from the northern Rocky Mountains." It is evident that the Nuttallian specimens of *P. Mexicanum* both in the Philadelphia and the Torrey herbaria belong to the same species as Gray's *P. viscosum*, which is a very near relative of *P. pulchellum*, at least as that species is understood in America, differing mainly in the smaller flowers. Flodman, Spanish Basin, nos. 739 and 740. 1896.

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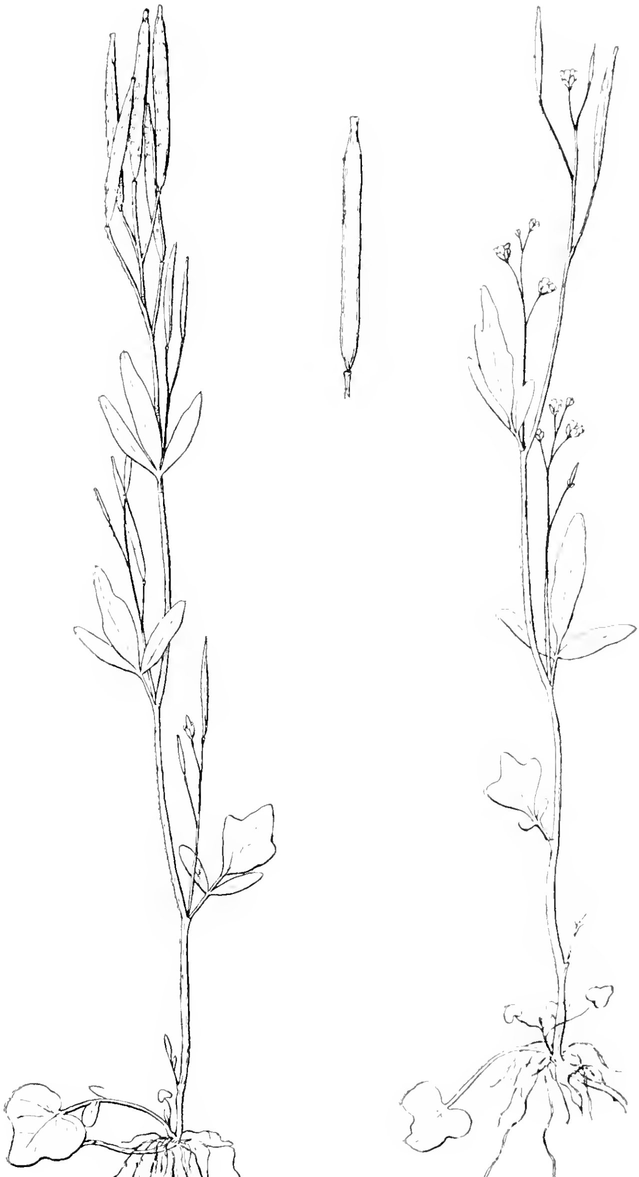
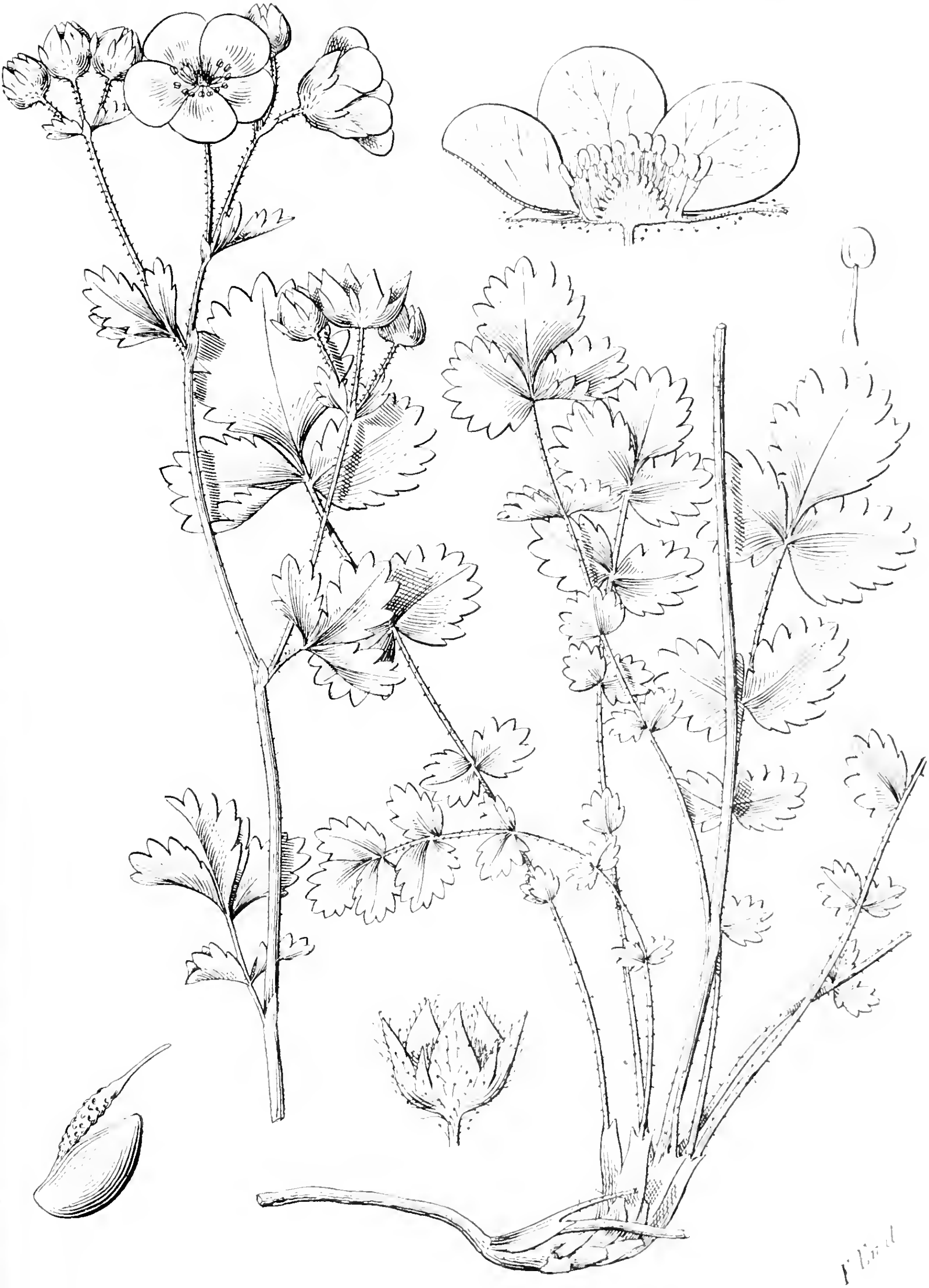
* Syn. Fl. 2: part 1, Suppl. 412.



CARDAMINE UNIJUGA RYDBERG.

1–2 MITELLA VIOLACEA RYDBERG.
3 THEROFON HEUCHERAEFORME RYDBERG.
4 THEROFON JAMESII (TORR.) WHEELOCK.

POTENTILLA CONVALLARIA RYDBERG.



POTENTILLA PSEUDORUPESTRIS RYDBERG.

Rarities from Montana.—III.

By P. A. Rydberg.

Pedicularis Montanensis.

Stem 3–4 m. high, simple, rather slender, more or less tinged with dark purple, glabrous; leaves pinnate, glabrous; segments ½–1 inch long, lanceolate, doubly serrate; spike short and dense, 3–6 cm., seldom 8 or 9 cm. long; bracts ovate, acuminate, about half as long as the flower, puberulent and villous-ciliolate and more or less purple-tinged as well as the calyx; calyx-lobes subulate; corolla 1.5 cm. long, purplish except a part of the lip which is yellow; galea much longer than the lip, lower portion straight, the apex cucullate and the tip not rostrate; lip 3-cleft, lateral lobes rounded and broad, middle one generally truncate and ciliolate at the margin.

A very near relative of *P. bracteata*, and perhaps only a variety thereof. The habit and form of the leaves are the same, except that *P. Montanensis* is a much more slender plant and has a shorter spike. In *P. bracteosa* the spike is often 2–3 dm. long, the bracts, especially the lower, fully as long as the light yellow corolla, the lateral lobes of lip are smaller.

Type: J. H. Flodman, no. 796, from Little Belt Mountains, nine miles from Barker, August 18, 1896.

PEDICULARIS CTENOPHORA.

Stem from a thickened caudex, about 3 dm. high, glabrous, strict, striate; leaves numerous, especially at the base, glabrous, rather thickish, pinnately divided into linear-lanceolate serrate segments; spike about 1 dm. long, rather loose; bracts broadly ovate in outline, pectinately divided; calyx gibbous above, purple-striate, more or less villous-ciliate at the base; corolla purplish; galea arcuate, produced into an elongated incurved beak; lip very broad, especially the lateral lobes.

It is a near relative of *P. contorta*, from which it differs in the color of the flowers, the more gibbous and purple-striate calyx, its hairiness at the base and the much larger and broader bracts.

Type: Rydberg, no. 2789, collected on the side of a snowclad mountain, near Lima, Montana, July 29, 1895.

GILIA CEPHALOIDEA n. sp.

G. spicata var. *capitata* Gray, Syn. Fl. **2**; part 1, 144, 1886 (in part): not Proc. Am. Acad. **8**: 274, 1870, nor *G. capitata* Sims, Bot. Mag. **53**: *pl. 2698.* 1826.

Jenney's plant collected in the Black Hills of South Dakota was included by Gray in the Synoptical Flora in *G. spicata capitata*. It is however scarcely the same as Hall & Harbour's no. 461, the type of the variety. The species, represented by Jenney's plant, my own no. 886, collected 1892, in the same region and no. 2764 collected near Lima, Mont., in 1895, differs from *Gilia spicata* not only in the subcapitate inflorescence, but also in the form and color of the flower. In *G. spicata* the corolla is greenish or dull white, has a tube which is fully twice as long as the calyx, and oblong segments that are only one-third the length of the tube. In *G. cephaloidea* the corolla is pure white, tube only ⅓ or ½ longer than the calyx and the segments elliptical and about half as long as the tube. The leaves are fully as much divided as in the former, but the plant is more woolly.

LAPPULA AMERICANA (Gray).

Echinospermum deflexum var. *Americanum* Gray, Proc. Am. Acad. **17**: 224.

I think this is quite distinct from the European *L. deflexa.* The species of the Mississippi Valley and westward is a much larger plant, with a many-flowered divergently paniculate-branched inflorescence and broadly oblanceolate leaves. The European *L. deflexa* has almost linear leaves. *L. Americana* was collected by the author at Deer Lodge, Mont., in 1895 (no. 2775), a point much further west than the supposed range of the species.

ERIGERON OBLANCEOLATUS.

Stem from an apparently biennial root, 3–5 dm. high, striate, finely strigose, branched above; basal and lower leaves oblanceolate, tapering into a winged petiole, pointed, the margins ciliolate and with a few small but sharp teeth; stem-leaves linear, diminishing upward, the uppermost bract-like; heads 1–3, comparatively large, 15–25 mm. in diameter and about 10 mm. high; bracts 40–50, narrowly linear, acuminate, strigose; rays numerous, generally about 100, very narrow.

In the size and form of the head and bracts it most resembles *E. speciosus* and *E. subtrinervis.* In general habit it resembles somewhat *E. glabellus* Nutt., but differs by the much larger heads, the toothing of the lower leaves and the weak root system, which indicates a biennial, or a perennial by biennial offsets (the specimens show no stolons). In the latter case the plant should be placed nearest *E. Philadelphicus*, from which it is easily distinguished by the thin narrow leaves, the form and size of their teeth and by the few and larger heads.

Montana: Deer Lodge, July 10, 1895, collected by the author, no. 2822; Helena, June, 1889, by F. D. Kelsey.

ERIGERON ASPERUGINEUS (D. C. Eaton) Gray, Proc. Am. Acad. **16**: 91. 1882.

Aster asperugineus D. C. Eaton, Bot. King's Exp. 142. 1871.

This species was collected at Melrose, Mont., July 6, 1895, no. 2823.

ERIGERON SUBCANESCENS.

Diplopappus canescens Hook. Fl. Bor. Am. **2**: 21. 1834.

Erigeron canescens T. & G. Fl. N. Am. 2: 179. 1841–2. Not Willd.

This was included in *E. caespitosum* Nutt. by Dr. Gray, but I believe it to be a fairly good species, differing by the more slender and erect stems, the longer and narrower leaves, finer pubescence, smaller heads and narrower bracts.

It was collected by Flodman in the Spanish Basin, July 22, 1896, no. 836.

ERIGERON ANGUSTIFOLIUS (Gray).

Aster salsuginosus var. *angustifolius* Gray, Bot. Calif. 1: 325. 1876.

E. salsuginosus var. *angustifolius* Gray, Proc. Am. Acad. 16: 93. 1880.

From the field observations of Mr. Flodman and myself, I judge this to be as good a species as most of the group. It was collected by Flodman near the Little Belt Pass, Aug. 10, 1896, altitude 7000 ft., no. 854.

ERIGERON MINOR (Hook).

E. glabratus var. *minor* Hook. Fl. Bor. Am. 2: 18. 1834.

E. armeriaefolius Gray, Proc. Am. Acad. 8: 648. In part. 1870. Not Turcz.

Gray includes in *E. armeriaefolius* two distinct American plants. Neither agrees with the original description. One of these is Hooker's *E. glabratus minor*, the other his *E. lonchophyllus*. A duplicate of the type of the former is in the Columbia herbarium. There are also the following specimens of the same plant:

Oregon: T. J. Howell, no. 3884. 1884.

Montana: J. H. Flodman, no. 839, 1896; P. A. Rydberg, no. 2824. 1895.

Northwest Territory: John Macoun. 1879.

South Dakota (Black Hills): P. A. Rydberg, no. 786. 1892.

Colorado: M. E. Jones, no. 471. 1878.

All these specimens differ from those cited under the following species in the following respects: The stem is low, 1–2 dm. high, very leafy; basal leaves numerous, the lowest spatulate; stem leaves linear, without petioles, ciliate at the base; inflorescence racemose, with heads on very short pedicels.

ERIGERON LONCHOPHYLLUS Hook. Fl. Bor. Am. 2: 18. 1834.

E. armeriaefolius Gray, l. c., in part. Not Turcz.

This is generally 3–6 dm. high; leaves rather scattered; basal leaves rather few and oblanceolate; stem leaves, except the uppermost, with distinct petioles; inflorescence more irregular and heads generally on elongated pedicels. The following specimens are in the Columbia Herbarium:

Utah: E. Palmer, no. 221. 1877. M. E. Jones, no. 1859. 1880.

Nevada: S. Watson, no. 536. 1868.

Montana: Rydberg, no. 2825. 1895.

ERIGERON MONTANENSIS n.n.

E. Tweedyana Canby & Rose, Bot. Gaz. 15: 65. 1890. Not *E. Tweedyi* Canby, Bot. Gaz. 13: 17. 1888.

This species has been collected again in Montana by J. H. Flodman, at the following stations: Elk Mountains, no. 837; Little Belt Mountains, near the Pass, no. 838.

ARTEMISIA GRAVEOLENS.

Perennial, somewhat woody at the base, with numerous simple branches, these strict and striate, glabrous; leaves twice or thrice pinnately dissected into narrow divisions, glabrous, or finely grayish pubescent beneath; heads in a narrow strict panicle, distinctly pedicelled, about 4 mm. in diameter; bracts ovate, glabrous, with a brownish scarious margin; flowers brown; whole plant heavy-scented and covered with glutinous dots.

It comes nearest to *A. discolor*, from which it differs in being almost glabrous, the pedicelled, not nodding heads, and the heavy scent.

Type: J. H. Flodman, no. 881, from Long Baldy in the Little Belt Mountains, Aug. 19, 1896. Also collected by Frank Tweedy, no. 310, in Park county, 1887.

ARTEMISIA CANDICANS.

Stem stout, nearly 1 m. high, tomentose, branched; leaves pinnately or twice pinnately divided into oblong segments, tomentose on both sides, grayish above, white beneath; heads sessile in clusters in a compound interrupted spike, 5–8 mm. in diameter; bracts oval, scarious-margined and tomentose.

It somewhat resembles *A. Tilesii elatior* T. & G. in habit but differs in the leaves, which are tomentose on both sides and have shorter not acuminate segments, and in the somewhat larger, strictly sessile heads with tomentose bracts.

Type: J. H. Flodman, no. 882, 1896, from Little Belt Mountains.

ARTEMISIA FLOCCOSA.

Stem stout, 5–7 dm. high, striate, tomentose; leaves pinnately divided into oblong segments, loosely white-tomentose on both sides; heads 5–6 mm. in diameter, erect, evidently pedicelled, in an elongated narrow raceme or panicle; bracts oval, scarious-margined and tomentose.

It is nearly related to the preceding, differing mainly in the looser tomentum, and the erect pedicelled slightly smaller heads. From *A. Tilesii elatior* it differs in the tomentum, the form of the leaves, and the erect heads with tomentose bracts.

Type: P. A. Rydberg, no. 2942, Lima, Aug. 6, 1895.

ARNICA FULGENS Pursh, Fl. Am. Sept. 2: 527. 1814.

I think that this is distinct from *A. alpina*, differing in the following characters: taller, stem often 3–4 dm. high, shorter pubescence, often 3 or 4 smaller heads, much broader and dentate leaves and often as many as many as 3 or 4 pairs of stem leaves.

It was collected by Mr. Flodman at Little Belt Pass, no. 891. 1896. My own specimens, no. 823, from the Black Hills, also belong here.

ARNICA GRACILIS.

Stem slender, 1–2 dm. high; whole plant glabrous, except a little glandular puberulence on the pedicels and involucre; basal leaves broadly ovate, petioled, dentate, 3-ribbed; stem leaves about 2 pairs, similar, the upper sessile; heads 1–3; disk 10–15 mm. high; bracts 12–15, oblong-lanceolate, acuminate; rays about 15 mm. long; achene almost glabrous.

It much resembles the preceding and may perhaps be a form of it, but differs by the smaller heads, the glandular-puberulent involucre and pedicels and the glabrous foliage and stem. It approaches depauperate forms of *A. latifolia*.

Type: J. H. Flodman, no. 901, 1896, from the Spanish Peaks.

ARNICA PEDUNCULATA.

Stem 3–6 dm. high, finely villous-pubescent, striate; basal leaves broadly oblong to almost linear, entire, 3-ribbed, tapering into a more or less winged petiole; stem leaves about 2 pairs, similar, but narrower and sessile; head on a peduncle that is often 2–2½ dm. long; bracts 18–20, linear or lanceolate, acute but not acuminate, villous-pubescent: disk 15–18 mm. high; rays fully 1½ cm. long, orange; achenes hirsute, pubescent.

It is somewhat between *A. foliosa incana* and *A. alpina* in habit, but differs from both by the long-peduncled solitary head and finer pubescence. It was collected by J. H. Flodman in the Spanish Basin, July 11, no. 899 (broad leaved) and July 10, no. 900 (narrow leaved), 1896. Also collected in Idaho by A. A. & Gertrude Heller, no. 3293, 1896, and in Washington during the Wilkes expedition.

SENECIO SALIENS.

S. triangularis β T. N. G. F: Am. 2 & 1. 441. 1834.

Periennial from a thick rootstock and numerous matted roots; stem stout, 3–5 dm. high, glabrous, striate; leaves fleshy, deltoid-triangular, with salient teeth, the lower petioled, the upper sessile; inflorescence short, corymbose; heads about 1 cm. high; bracts linear; rays about 8 mm. long; achenes glabrous.

It is nearest related to *S. triangularis*, differing in the lower stature, the smaller thick and rather fleshy leaves, with fewer coarser less pointed teeth. The following specimens belong to it:

Montana: J. H. Flodman, no. 919, 1896, from Yogo Baldy in the Little Belt Mountains, altitude 7000 feet.

Wyoming: Fremont, in the Wind River Mountains, altitude 7000 feet.

Washington: Frank Tweedy, 1883, Yakima Region, altitude, 6700 feet.

SENECIO PSEUDAUREUS.

Perennial from a creeping rootstock; plant perfectly glabrous except the tips of the bracts; stem 5–8 dm. high; basal leaves broadly ovate, somewhat cordate at the base, serrate, 4–7 cm. long, long-petioled; stem leaves more or less laciniate at the base, the upper sessile; inflorescence corymbose, flat-topped, of 8–10 heads about 8 mm. high; bracts linear; rays orange, about 8 mm. long.

It most resembles *S. aureus* and represents it in the Rockies. It has the same large basal leaves as that species, but they are less cordate at the base, not quite as wide and serrate instead of crenate. *S. aureus* is a strictly Eastern species.

Montana: J. H. Flodman, no. 918, from Little Belt Mountains (type), and 918½ from Spanish Basin, 1896; Frank Tweedy, no. 340, Park county, 1887.

Nevada: S. Watson, no. 667, 1868.

SENECIO CROCATUS.

S. aureus var. *croceus* Gray, Proc. Acad. Phila. 1863: 68. 1863. Not *S. croceus* DC.

This is well distinct from both the preceding and from *S. aureus*, differing in its smaller oval or obovate, coarsely and bluntly dentate, somewhat fleshy basal leaves. It represents *S. obovatus* of the East. It was collected in Montana by Mr. Flodman in the Little Belt Mountains, near the pass, no. 911.

CREPIS RUNCINATA ALPICOLA.

Stem scapose, about 1 dm. high, generally only 1-flowered; leaves entire, or with a few small teeth, and with very short petioles.

In habit it is very unlike the typical *C. runcinata*, but I have been unable to find any essential characters in the heads, involucre, pappus or achenes, by which to separate it as a species. The short 1-flowered stem, smaller and more entire leaves may be due to the high altitude, 7000 feet, at which it grew.

Type: Flodman, no 931, August 24, 1896, from Yogo Baldy, Little Belt Mountains.

Antennaria dioica and its North American Allies.

BY P. A. RYDBERG.

In 1892 when I began to determine my Black Hills collection, I felt that there must be something wrong in the genus *Antennaria*, especially in the group of which *A. dioica* is the representative species. My studies then, my field work in 1895 and 1896, and Mr. Flodman's collection have made it possible I think to remove at least a part of the difficulty. What have been named in our herbaria *A. dioica* and *A. alpina* constitute not less than six distinct species. I suspected that *A. plantaginifolia* contains more than one species, but have not been able to satisfactorily solve the problem. This seems to have been done by Prof. E. L. Greene in a recent number of "Pittonia"; I shall, however, add a description of the prairie plant of Nebraska, Kansas and Dakota, referred to in Prof. Greene's paper. As far as I know the species at present, I shall arrange them as follows:

Heads sessile at the ends of short leafy branches resembling the stolons. *A. rosulata.*

Heads in cymose or subcapitate clusters, or solitary on evident erect stems.

- Basal leaves and those of the stolons narrowly oblanceolate; bracts generally rose-color. *A. parvifolia.*
- Basal leaves and those of the stolons spatulate or obovate.
  - Basal leaves .5–4 cm. long and less than 1.5 cm. wide, one-ribbed or indistinctly three-ribbed.
    - Heads 5–7 mm. high.
      - Plants less than 1.5 dm. high; heads in subcapitate clusters.
        - Bracts of the pistillate plant dark greenish brown, acute or acuminate. *A. alpina.*
        - Bracts of the pistillate plant umber, obtuse. *A. umbrinella.*
      - Plants generally over 2 dm. high; heads in an open cyme.
        - Basal leaves ½–1 cm. long; stem leaves linear. *A. microphylla.*
        - Basal leaves 2–3 cm. long; stem leaves spatulate, broadly oblong and ovate-lanceolate. *A. pedicellata.*
    - Heads about 1 cm. high.
      - Basal leaves broadly spatulate, with a distinct petiole, generally tomentose on both sides; bracts of pistillate plant obtuse, or the innermost seldom acute. *A. dioica.*
      - Basal leaves more glabrate above, without distinct petiole; bracts of pistillate plant acute or acuminate, or the outermost obtuse.
        - Stem slender, 2–3 dm. high; stolons very long; basal leaves narrowly cuneate. *A. neglecta.*
        - Stem stout, short, about 1 dm. high; stolons short; basal leaves obovate. *A. campestris.*
  - Basal leaves over 4 cm. long and 1.5 cm. wide, prominently 3 ribbed.
    - Heads cymose; bracts of pistillate plant lanceolate.
      - Basal leaves broadly cuneate without distinct petiole. *A. Howellii.*
      - Basal leaves oval with a distinct petiole. *A. plantaginifolia.*
    - Head solitary; bracts of pistillate plant almost linear. *A. solitaria.*

Heads racemose or paniculate. *A. racemosa.*

Antennaria rosulata.

Antennaria dioica var. *congesta* Gray, Syn. Fl. 1: pt. 2, 233. At least in part. 1884. Not DC.

The two sheets of the American plant found in the Columbia University herbarium differ considerably from European specimens in the same herbarium. The European is evidently a depauperate form of *A. dioica* or at least nearly related to it. The American plant, besides having a more trailing habit, possesses an almost turbinate involucre, of which only the innermost row of bracts have a broadly oblong obtuse papery appendage; the outer ones are even destitute of scarious margins. The whole involucre is densely white tomentose. Specimens seen: E. A. Mearns, no. 40, 1887, from the Mogollon Mountains, Arizona; E. Palmer, no. 109, 1869.

ANTENNARIA PARVIFOLIA Nutt. Trans. Am. Phil. Soc. 7: 406.

A. dioica var. *rosea* D. C. Eaton, Bot. King's Exped. 186. Name only. 1871.

Stems very slender, 1½–3 dm. high; pubescence of the whole plant fine, silky and somewhat yellowish; leaves of the stolons narrowly oblanceolate, 2–3 cm. long; stem leaves linear; heads small, 5–7 mm. high, in a contracted almost capitate cyme; bracts of both staminate and pistillate heads in several rows, yellowish, the scarious portion oblong, obtuse, nearly always tinged with rose or pink.

It is nearest related to *A. dioica*, differing in the slender habit, small heads, narrow leaves and the color of the plant and bracts; the staminate plant is very rare. The following specimens are in the Columbia herbarium:

California: Mrs. R. M. Austin, 1894; J. Torrey, no. 256, 1865.

Oregon: Wilkes expedition.

Washington: W. N. Suksdorf, no. 2190, 1892.

Idaho: A. A. & Gertrude Heller, no. 3441, 1896.

Nevada: S. Watson, no. 652, 1868.

Utah: M. E. Jones, no. 1390, 1879.

Colorado: Parry; F. N. Pease; Dr. E. Penard, nos. 282 and 284, 1891.

South Dakota (Black Hills): P. A. Rydberg, no. 79, 1892.

Montana: J. H. Flodman, no. 863, 1896.

Vancouver Island: John Macoun, 1887.

Subarctic America: R. Kennicott, 1861–62.

ANTENNARIA ALPINA (L.) Gaertn. Fr. & Sem. 2. 410. 1791.

Gnaphalium alpinum L. Sp. Pl. 856. 1753.

A. alpina is characterized by the bracts of the pistillate head, which are dark greenish brown, lanceolate and acute. The staminate plant is exceedingly rare; in the Columbia herbarium there are only three small plants, two, both monocephalous, collected by M. W. Harrington in Alaska, and the third received from Dr. Hooker, without any reference to locality or collector.

A. alpina has been collected in Montana by J. H. Flodman on Yogo Baldy, August 24, 1896, no. 861; Long Baldy, August 19, no. 862, and by Frank Tweedy in the Bozeman Pass, 1883.

ANTENNARIA UMBRINELLA n. sp.

Stem generally about 1 dm. high; leaves of the stolons spatulate, 1–1.5 cm. long, those of the stem linear-oblong; heads small, about .5 cm. high, conglomerated in small subcapitate clusters; scarious portion of the bracts in the pistillate head oblong, obtuse, in the outer varying from umber to isabel-colored, in the inner lighter colored and sometimes almost white; in the staminate heads all elliptic, obtuse and isabel-colored or yellowish white.

In habit it much resembles *A. alpina*, from which it differs by the oblong obtuse bracts of the pistillate plants and somewhat smaller heads. The staminate plants of the two species are almost identical in every respect except that the bracts are of slightly lighter color in *A. umbrinella*. I describe this species as new, with some hesitation, not that I have any doubt concerning its distinctness from *A. alpina* and our North American species, but it is so closely similar to *A. Magellanica* Sch. Bip.* that if it were not for the great distance between their ranges and for the slightly longer leaves and more slender caudex of the latter, I would regard the two as one species. The staminate plants are nearly as common as the pistillate ones. The following specimens are in the Columbia herbarium:

Montana: J. H. Flodman, no. 859, August 19, 1896, from Long Baldy in the Little Belt Mountains (type) and no. 860, July 18, from Spanish Basin.

Wyoming: Aven Nelson, no. 885, 1894 (labelled *A. dioica*).

Nevada: S. Watson, no. 650 (*A. alpina*) and 651, 1868.

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* Flora 38: 117. 1855.

Idaho: I. Mulford, 1892 (*A. dioica*).

Oregon: Wilkes Expedition (*A. dioica*).

Arctic America: Dr. Richardson, 301 (*Gnaphalium dioicum*).

ANTENNARIA MICROPHYLLA.

Stem slender, strict, 2–3 dm. high; pubescence very fine; leaves of the stolons small, .5–1 cm. long, spatulate; stem-leaves linear-oblong; heads small, 5–7 mm. high, in a rather open corymb; bracts of the pistillate heads tinged with greenish yellow, linear-oblong or lanceolate, mostly acute, those of the staminate head with oval-oblong white scarious margins.

In the characters of the head and bracts, it is intermediate between *A. alpina* and *A. plantaginifolia*. The head is scarcely as large as that of the former, the stem is much more slender than in either and the leaves smaller than in any of the group. It has been variously labelled in collections as *A. dioica*, *A. luzuloides*, *A. Carpatica*, etc. The following specimens are in the Columbia herbarium:

Montana: P. A. Rydberg, no. 2831, 1895, from Manhattan (type); J. H. Flodman, no. 864, 1896, from Bozeman.

Yellowstone National Park: Frank Tweedy, no. 203, 1884; A. Brown, 1893.

Wyoming: Fremont; A. Nelson, no. 762.

Colorado: C. C. Parry, 1872; Letterman, no. 200, 1884.

Utah: S. Watson, no. 651, 1869.

Saskatchewan: E. Bourgeau, 1858.

ANTENNARIA PEDICELLATA Greene, Pittonia, 3: 175. 1897.

Specimens of what I take to be this species were collected by Mr. Flodman in the Little Belt Mountains, Mont., in 1896, no. 867. These have large stem leaves about 3 cm. long and 1 cm. wide; the lower ones are cuneate, obtuse, the middle ones broadly oblong and the upper ones ovate-lanceolate and acute.

ANTENNARIA DIOICA (L.) Gaertn., Fruct. & Sem. 2: 410. 1791.

Gnaphalium dioicum L. Sp. Pl. 856. 1753.

In the American specimens seen the stem is seldom 1.5 dm. high, rather stout, with larger heads often over 1 dm. high, the scarious portion in the staminate heads elliptic, in the pistillate oblong and obtuse, or the innermost rarely acutish, and the leaves of the stolons broadly spatulate, or obovate, about 2 cm. long. In America it ranges from the Arctic regions to New Mexico and Arizona, and is the most common species in Montana.

For ANTENNARIA NEGLECTA Greene, A. PLANTAGINIFOLIA (L.) Hook. and A. HOWELLII Greene, see Prof. E. L. Greene's descriptions in Pittonia, 3: 173–4.

ANTENNARIA CAMPESTRIS n. sp.

Stem low, about 1 dm. high; basal leaves obovate-cuneate, 2–3 cm. long and about 1 cm. wide, without a distinct petiole, 1-ribbed or indistinctly 3-ribbed, the upper surface glabrate in age; stolons very short; pistillate heads about 1 cm. high, bracts lanceolate. the lower portion greenish, the upper brownish and ending in a scarious white acute or acuminate tip; staminate heads somewhat smaller; the white scarious tips of the bracts elliptical and obtuse.

It is nearest related to *A. neglecta* Greene, from which it differs mainly in the low habit, broader basal leaves, and short stolons. It is confined to the prairies and plains west of the Mississippi.

Nebraska: H. J. Webber, 1887; G. D. Swezey; J. M. Bates, 1891; P. A. Rydberg.

South Dakota: P. A. Rydberg, no. 794, 1892 (Black Hills).

Saskatchewan: Dr. Richardson.

ANTENNARIA SOLITARIA n. n.

Gnaphalium monocephalum Carpenter, in Torr. & Gray, Fl. N. Am. 2: 431. 1843.

Antennaria plantaginifolia monocephala Torr. & Gray, l. c.

Antennaria monocephala Greene, Pittonia, 3: 176, 1896. Not DC. Prod. 6: 269. 1837.

To the characters given by Prof. Greene, may be added the exceedingly narrow bracts of the pistillate head.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 122.

Studies in the Botany

of the

Southeastern United States.—XI.

BY JOHN K. SMALL.

[Reprinted from THE BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 24, No. 7, July 29, 1897.]

Studies in the Botany of the southeastern United States.—XI.

By John K. Small.

I. Noteworthy Species.

Sagittaria filiformis J. G. Smith, Rep. Mo. Bot. Gard. 6: 46. *pl. 15.* 1894.

Mr. A. H. Curtiss has sent me fine fruiting specimens of this rare species, collected near Jacksonville, Florida. They are apparently the first specimens found with mature achenes; these are of the same general outline as the immature achenes figured by Mr. Smith, but slightly broader. In the center of each face there is an oblong swelling surrounded by a depression, while the edges are crested. The lengths of numerous achenes vary from 1.5–2 mm.

ARENARIA BREVIFOLIA Nutt.; T. & G. Fl. N.A. 1: 180. 1838.

I have long suspected the occurrence of this, the rarest of our eastern American *Arenarias*, in North Carolina. In 1890 Mr. Heller collected fragmentary and imperfect specimens of an *Arenaria* in Rowan County. Some years later I found similar specimens on Dunn's Mountain, near Salisbury. During the spring of 1896 I had an opportunity to visit Dunn's Mountain and found the species in full bloom just as it occurs on Stone Mountain, Georgia; the plants from the two mountains are almost identical.

RHEXIA MARIANA L. Sp. Pl. 346. 1753.

As far as I have observed, *Rhexia Mariana* prefers sandy places at no great distance from the Atlantic and Gulf coasts, although it does occur at many points in the middle districts of the Southern States, and is said to extend up the Mississippi Valley to Missouri. The first altitude worthy of note at which I found the species was at about 300 meters on Stone Mountain, Georgia. The following year, 1895, I collected a few specimens of a delicate form, apparently referable to this species, on the mountains near Ellijay, Gilmer County, Georgia, at an altitude of about 400 meters. The leaves of this form are thin, oval, ovate or elliptic and short-petioled. Much to my surprise, on reaching the summit of Table Mountain, South Carolina, last summer, I found the typical state of the plant thriving at an altitude of almost 1000 meters.

SABBATIA CAMPANULATA (L.) Britton, Mem. Torr. Club, 5: 259. 1894.

Dr. Gray has recorded * the mountains of Georgia as an extension of the range of this normally coast plant. I do not know to how great an altitude the species ranges in Georgia, but I have collected it at an elevation of nearly 1000 meters on the summit of Table Mountain, South Carolina, and the only noticeable difference between the mountain specimens and those from the low-

* Syn, Fl. 2: Part 1, 115.

lands is the proportionate breadth of the leaves, these being wider in the plants from the higher altitudes.

PHACELIA HIRSUTA Nutt. Trans. Am. Phil. Soc. (II.) 5: 191. 1833–37.

Although classed as an annual, this *Phacelia* appears to be a biennial. Mr. Nuttall, in the original description, says "annual or perhaps also biennial." On Stone Mountain, Georgia, the species flowers in the spring, the plants soon die and disappear on account of the extreme heat, the seeds falling to the ground at once germinate, producing tufts of spatulate, oblong-spatulate or obovate, short-petioled, sharply serrate leaves which are not in the least pinnatifid, as are those of the following season.

VITEX AGNUS-CASTUS L. Sp. Pl. 637. 1753.

This shrub is fast becoming naturalized in the Southern States. Miss K. S. Taylor found it about Columbia, South Carolina, in 1891, and I collected it in 1895 at both Darien and near Fort Barrington, in southeastern Georgia.

CESTRUM PARQUI L'Her. Stirp. Nov. 73. 1783–84.

We have no record of the occurrence of this species on our eastern sea-board, but it is now doubtless established at many places in the Southern States. In 1895 I found quantities in and about Darien, Georgia.

LEONOTIS NEPETAEFOLIA Ait. Hort. Kew. Ed. 2, 3: 409. 1811.

Dr. Chapman reports this introduced plant from Georgia and Florida. We now have excellent specimens collected by Prof. Underwood at Auburn, Lee County, Alabama.

FILAGO NIVEA.

Evax multicaulis DC. Prodr. 5: 459. 1836. Not *Filago multicaulis* Lam. 1778.

This is one of the Compositae belonging west of the Mississippi River that has been traveling gradually eastward; in 1895 I found it very plentiful about Stone Mountain, Georgia.

II. New Species.

Listera reniformis.

Perennial, fleshy, deep green. Stem erect, 1–3 dm. tall, slender glabrous or nearly so below, densely glandular-pubescent above, simple; leaves 2, opposite, about the middle of the stem, reniform or ovate-reniform, 1–3 cm. in diameter, apiculate or short acuminate, glabrous above, more or less pubescent beneath, cordate or subcordate, sessile; racemes 2–10 cm. long; flowers greenish; bracts lanceolate or ovate-lanceolate, 3–5 mm. long, acute; pedicels slender, 4–7 mm. long, glabrate, or much less pubescent than the stem; sepals oblong or linear oblong, about 3 mm. long, obtuse or acutish, reflexed; lip wedge-shaped, 6–7 mm. long, with 2 prominent teeth on both sides near the base, sharply cleft to near the middle, the lobes rounded; capsules oval, 4–5 mm. long; mature seeds not seen.

Damp thickets on the mountains of Maryland, Virginia and North Carolina, ranging from about 1000 to 1750 meters altitude. Spring and summer.

It seems strange that this well marked species should have been so long associated with the northern *Listera convallarioides* It is confined to the higher parts of the southern Alleghany mountains, while *Listera convallarioides* appears to have a northern transcontinental range suggesting that of *Polygonum Douglasii. Listera reniformis* differs from its northern relative in its more slender habit, the reniform type of the leaves, which are apiculate or short-acuminate at the apex and cordate or subcordate at the base, and the lip, which is sharply cleft, often nearly to the middle, by a V-shaped sinus. The leaf of *Listera convallarioides* is oval and obtuse at both ends, while the lip is cut by a U-shaped sinus.

Asarum callifolium.

Perennial, deep green, nearly glabrous. Leaves tufted, long-petioled, the blades ovate, 5–9 cm. long, obtuse or sometimes acutish, finely undulate or crenulate, rarely mottled, deeply cordate at the base; petioles 2–3 times longer than the blades, sparingly pubescent; bracts reniform, ciliate; pedicels as long as the calyx, or much shorter; calyx urn-shaped, 1.5–2.5 cm. long, dark green without, dark purple within, the segments broadly ovate or broader than high, the throat slightly contracted; stigmas 2-cleft, capsule not seen.

In shady woods, Florida. (Chapman.)

This is probably the *Asarum arifolium* of Dr. Chapman's Flora, but not the plant of Michaux, specimens of which I have never seen from further south than Georgia. It differs from *Asarum arifolium* in both foliage and infloresence. The leaf-blades are simply ovate, and lack the halberd-shape so characteristic of those of the Michauxian plant, and the margin instead of being entire is finely undulate or crenulate. The pedicels are always short, never elongating like those of *A. arifolium*, while the perianths of the two species are entirely dissimilar in shape; that of *Asarum callifolium* being larger, much shorter in proportion to the length and with a rounder base.

ARISTOLOCHIA CONVOLVULACEA.

Perennial, slender, bristly-pubescent throughout. Stems erect or decumbent, 1–3 dm. long, angled, slightly flexuous, simple, or rarely branched below; leaves thinnish, becoming firm at maturity, broadly ovate to oval, 2–8 cm. long, short-acuminate or rarely acute, ciliate, deeply cordate at the base, short-petioled; petioles .5–1.5 cm. long, hirsute; peduncles slender, 1–2-flowered, flexuous, angled; calyx densely hirsute, the tube .5–1 cm. long, the limb 6–8 mm. broad, scarcely lobed; capsule subglobose, 6–7 mm. in diameter, pubescent.

In woods, " . . . Columbus, Georgia. Grows from Athens to near this place" (Boykin).

Dr. Boykin noticed the differences between *Aristolochia Serpentaria* and the one here described as new, many years ago. Besides observing the plant in the field, he cultivated it in his garden, and sent both native and cultivated specimens to Dr. Torrey in whose herbarium they are preserved.

Aristolochia convolvulacea can readily be distinguished from *A. Serpentaria* by eithe. the pubescence or the foliage. In place of the soft pilose hairs characteristic of *Aristolochia Serpentaria*, we find a bristly-hirsute pubescence on all parts of the plant. The leaves are much broader in proportion to their length than those of its relative, resembling closely those of some Convolvulaceae, whence the name.

PARONYCHIA SCOPARIA.

Perennial, rather slender, the foliage minutely pubescent. Stem much branched at the base, the branches tufted, erect or ascending, 2–3 dm. tall, simple below, sparingly forked above, roughish; leaves linear-filiform, 1–3 cm. long, acute, grooved on either side of the midrib, serrulate-ciliate, especially near the apex, sessile; stipules linear-lanceolate, 1–1.5 cm. long, attenuate; branches of the cymes erect or strongly ascending; sepals linear-lanceolate, gradually narrowed to the apex, 3–3.5 mm. long, firm, keeled, usually with a short lateral nerve on each side of the keel, hooded, prolonged into a stout ascending cusp, which is one-third to one-fourth as long as the body; petals none; stamens half as long as the sepals; anthers yellowish.

The specimens on which the above species is founded were collected by Dr. Edward Palmer, in the Indian Territory, between Fort Cobb and Fort Arbuckle, in 1868. (No. 27.)

As far as I know, *Paronychia scoparia* has not been referred to any previously described species. It is related to *P. dichotoma*, differing in the more robust habit, the minutely pubescent foliage and the strict few-flowered cymes. *Paronychia scoparia* has a larger calyx than *P. dichotoma*, the cusps are longer and more densely spiny-ciliate, and the calyx-segments are more strongly ribbed on the back.

Paronychia chorizanthoides.

Annual, slender, minutely pubescent. Stem erect, 1–2 dm. tall, forking from a point 3–8 cm. above the base; leaves linear-filiform, .8–2 cm. long, acute, with a stout midrib, sessile; stipules lanceolate, silvery, acuminate; calyx short-pedicelled, or nearly sessile, 1.5 mm. long, strigose at the base, finally urn-shaped, the base much enlarged; sepals ovate or ovate-lanceolate, with a stout midrib, abruptly contracted into the ascending cusps which are about one-half as long as the body at maturity; utricle nearly 1 mm. broad.

The specimens on which the species here described as new is founded were collected by Dr. Edward Palmer at Bluffton, Burnet County, Texas, 50 miles west of Georgetown, October 10–15, 1879, according to printed ticket, or 1883, no. 1169, according to written label. Heretofore specimens of this collection have been referred to *Paronychia setacea*, which species, however, they but slightly resemble. *Paronychia chorizanthoides*, as the name suggests, bears a remarkable resemblance to some species of *Chorizanthe*, chiefly on account of the involucre-like calices. In *Paronychia chorizanthoides* the bracts subtending the calyx are shorter than that organ, while in *P. setacea* they are longer. The calyx of the new species is sharply diagnostic, being urn-shaped with a much enlarged base, the calyx of *P. setacea* being turbinate and narrowed at the base. The cusps terminating the sepals are much stouter and only about one-half as long as the very slender cusps of *P. setacea*. Mr. Heller's number 1729, distributed as *P. setacea*, is *Paronychia chorizanthoides*, but, being quite young, it has not yet assumed the characteristic habit that Dr. Palmer's specimens exhibit.

Siphonychia corymbosa.

Perennial, stoutish, the foliage pubescent with recurved hairs. Stem branched at the base, the branches tufted, 1–3 dm. tall, erect or ascending, olive-green or brownish, forking, especially above, ribbed, topped by the corymbosely disposed cymes; leaves oblanceolate to oblong-oblanceolate, .5–1.5 cm. long, acutish, ciliate, sessile; stipules ovate, silvery, long-acuminate; inflorescence silvery; calyx 2–2.2 mm. long, pubescent at the base, the segments oblong or ovate-oblong, white, longer than the tube, obtuse, concave, slightly hooded at the apex; stamens included; style exserted; utricle ovoid, 1 mm. long.

The original specimens were collected by Professor L. M. Underwood on Ship Island, on the coast of Mississippi, in June, 1896.

Siphonychia corymbosa is most closely allied to *Siphonychia erecta*, which it simulates in habit. The characteristic difference in appearance between the two species is in the foliage, that of *S. erecta* being glaucous, while that of the new species is clothed with a pubescence consisting of short recurved hairs; the inflorescence of *Siphonychia corymbosa* is more lax; the calyx furnishes good distinctive characters: that of the new species is shorter and stouter, the segments oblong, with converging tips, instead of lanceolate, with erect tips, as in that of *S. erecta*.

Clematis glaucophylla.

Perennial, bright green, glabrous. Stem rather slender, 2–5 meters long, climbing over bushes or trees, nearly simple, dark red, furrowed, much enlarged at the nodes; leaves ovate, 3–10 cm. long, thickish, acute, often apiculate or acuminate, entire, 3-lobed or trifoliolate, with conspicuous white nerves above, prominently nerved and glaucous beneath, cordate or subcordate; floral leaves with petioles 1 cm. long, the nerves gradually diverging from the midrib; flowers reddish purple, glossy, 2–2.5 cm. long; calyx conic-ovoid; sepals lanceolate, acuminate, the tips very slightly spreading; achenes suborbicular, 6–8 mm. in diameter, puberulent, abruptly narrowed at both ends, with an orbicular impression in the middle, sometimes slightly inequilateral, the plumose style erect or slightly oblique, 5–6 cm. long, tawny, lustrous, the hairs spreading.

Collected by the writer in the Yellow River valley, near McGuire's Mill, Gwinnett county, Georgia. In flower July 2, 1895, in fruit July 11, 1893.

A handsome species between *Clematis Addisonii* and *C. Viorna*, with foliage somewhat resembling that of the former and with the habit of the latter. It differs from *C. Addisonii* in its much elongated and climbing stem, and the distinctly petioled and acute floral leaves. It may readily be distinguished from *C. Viorna* by its suborbicular achene and longer plumose styles, as well as by the foliage.

LOBELIA FLACCIDIFOLIA.

Perennial, slender, deep green, glabrous or nearly so. Stems erect, 2–6 dm. tall, solitary, or loosely tufted, usually branched above, or, in small plants, rarely simple, the branches wire-like; leaves thin, the basal or lower cauline obovate or oblong-spatulate, the rest linear-oblong or rarely linear-lanceolate, 3–10 cm. long, obtuse, undulate or crenate-undulate, short-petioled; racemes interrupted, .5–2 dm. long, recurved; pedicels erect, slightly curved, 4–5 mm. long, usually exceeded by their bracts; calyx glabrous, its tube broadly turbinate, becoming globose-hemispheric and strongly ribbed, its segments linear-lanceolate, 4–5 mm. long, acute, spiny-toothed, auricled at the base, slightly revolute; corolla about 1.5 cm. long, blue, sparingly pubescent without, the segments of the upper lip reflexed, crisped, about ½ as long as the tube, the lower lip as long as the tube, its segments acute, the middle one lanceolate, the lateral ones oblong-lanceolate; staminal tube ascending, anthers pubescent; capsule ovoid, 5–8 mm. long, beaked, the free portion somewhat shorter than the part adnate to the calyx-tube.

In sand in deep river swamps, southern Georgia. Summer.

The species here described as new is, on the whole, most closely related to *Lobelia Ludoviciana*, from which it differs in the delicate habit, the very thin texture of the leaves and the branching stems; there are characters in the flower to separate it from the Louisiana plant in the narrower calyx-segments and narrower segments of the lips of the corolla.

The original specimens were collected by the writer in the Ochlockonee River swamp, near Thomasville, Georgia, July 12–22, 1895.

ASTER CAMPTOSORUS.

Perennial, slender. Stems erect, 4–6 dm. tall, finely ridged, slightly flexuous, green or purplish green, simple or nearly so, glabrous, or very sparingly pubescent near the top; leaves few, the blades lanceolate, 6–15 cm. long, resembling the leaves of *Camptosorus rhizophyllus*, attenuate from near the base to the finely acute apex, entire, undulate, sometimes crisped, dark green, smoth and lustrous above, paler and hispid beneath with a scattered pubescence, the lower ones deeply cordate at the rounded ear-like base, the upper ones subcordate or truncate, petioled; petioles slender, villous, the lower ones nearly as long as the blades, the upper about ⅓ as long as the blades; heads usually few; pedicels angled, bearing minute appressed bracts, scabrous with short, stiff, spine-like hairs; involucres cylindric-campanulate, constricted at the middle (or turbinate in the dry state), 5 mm. high, the bracts linear-subulate, in 4 or 5 series, incurved, with a narrow green midrib and green acute tip; corolla about 6 mm. long; stamens and style glabrous; rays purple, linear-oblanceolate, 1 cm. long, slightly 3-toothed at the apex.

In open woods, in and near the mountains, Georgia and Alabama. September to October.

A very curious and handsome species on account of the close resemblance of its leaves to those of *Camptosorus rhizophyllus*. Compared with its nearest relative, *Aster Shortii*, the new species is more slender and, in addition to the *Camptosorus*-like leaves, and the characteristic gradual attenuation from the base to the apex, these organs are smooth, dark green and lustrous above. The involucre of *Aster Shortii* is campanulate, whereas that of *Aster Camptosorus* is cylindric-campanulate and constricted at the middle; the bracts in the new species are rigid, linear-subulate and incurved, while those of *Aster Shortii* are rather thin, hardly rigid and simply linear.

Fine specimens were sent to me by Prof. Carl F. Baker from Wright's Mill, five miles south of Auburn, Alabama. They were collected on October 17, 1896. In addition to these I find an old sheet in the Columbia University Herbarium on which are two specimens collected in the mountains of Georgia by Mr. Buckley.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 123.

New or Noteworthy American Grasses.—VII.

By George V. Nash.

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New or noteworthy American Grasses.—VII.

By George V. Nash.

Erianthus laxus n. sp.

Culms erect, stoutish, 2–3 metres tall, pubescent with appressed hairs, toward the base scanty and short, at the apex longer and copious. Nodes densely pubescent with appressed grayish hairs; sheaths striate, the inner surface spotted and tinged with red-brown, the outer surface densely hirsute with ascending gray hairs, the lower sheaths throughout, the upper ones only at the base and apex, with the intermediate portion but sparingly pubescent; ligule 3–4 mm. long, rounded at the apex, irregularly lacerate-toothed; leaves flat, 2–5 dm. long, 6–12 mm. wide, long-acuminate at the apex, a little narrowed toward the base, rough on the margins, hirsute on both surfaces, the upper surface becoming glabrous when old; panicle gray in hue, 4–5 dm. long, 1 dm. wide or less, loose, the main axis copiously pubescent with long, silky appressed hairs, as are also the elongated lax and flexuous ascending branches, the larger of which are 2–2.5 dm. long; internodes of the rachis densely pubescent with silky hairs, 6–8 mm. long, the lower internodes much exceeding the spikelets; spikelets 4–5 mm. long, one-half as long as the basal hairs, and about one-half again as long as the clavellate pedicels, which are pubescent with very short appressed hairs, and also with fewer long ascending hairs; outer scales of the spikelet pubescent with long hairs, at least at first, the first scale slightly 2-toothed at the apex, the second similar, but not so distinctly nerved, the third scale pubescent on or near the margins toward the apex, the fourth scale glabrous, or with a few hairs at the apex, purple on the margins, acuminate into a scabrous, untwisted, straight or somewhat contorted awn about 2 cm. long.

Collected by Mr. W. T. Swingle in a wet hammock between Paola and the Wekiva River, along the J. T. & K. W. R. R., on Aug. 22, 1894, No. 1732a of my first distribution of Florida plants.

The elongated branches of the panicle, the long internodes of the rachis, and the longer basal hairs of the spikelet distinguish this at once from any form of *E. saccharoides*, to which it is related.

PANICUM AGROSTIDIFORME Lam. Ill. 1: 172. 1791.

This name was given by its author to a grass from South America, probably from Cayenne, and its application to the plant so common in our region, the *P. agrostoides* Muhl., has never been satisfactory, not only because the description failed to fit our plant, but also on account of the remoteness of the region from which the Lamarckian plant originally came—a region the flora of which is tropical and not likely to contain among its members a grass native and plentiful in the eastern United States. A careful comparison of a fuller description of this plant, in Encycl. Meth. (4: 748. 1797), with material from northern South America, where this grass was originally secured, leaves little doubt as to its proper identification. Among the characters given by Lamarck is that of the ciliate margins of the sheath fissure. There are three specimens in the herbarium of Columbia University which show this character in a marked degree, one of them from northern South America, another from Turk's Island, W. I., and the third from Truando Falls, on the Isthmus of Panama, collected by Schott. These specimens agree with the description of Lamarck, in the height and the jointed and leafy character of the culms, and in the size and form of the panicle, and the arrangement of its spikelets. The culms arise from a creeping base, a character about which Lamarck says nothing, his specimens probably not exhibiting this feature. It differs from *P. agrostoides* Muhl. in the ciliate margins of the sheaths, in the shorter leaves, the smaller spikelets, and the creeping base of the stem. In *P. agrostoides* Muhl. the leaves are much elongated, the margins of the sheaths entirely naked, and the culms are caespitose, or at all events not creeping at the base.

The plants in the herbarium of Columbia University to which allusion is made, and which are referable to this species, are:

"I. F. Holton, La Paila, April 19, 1853, No. 91," sent out in his distribution of plants from "Neogranadina-Caucana."

"Graminaceae. Saxicolae. Ripariae. Truandofalls. Schott II. 858," and in red ink "No. 6."

"Dr. Madiana, Turk's Island."

PANICUM ATLANTICUM n. sp.

Whole plant, with the exceptions noted below, papillose-pilose, with long white spreading hairs, the hairs on the upper surface of the leaves and on the summit of the culm scantier, those on the lower surface of the leaves shorter. Culms caespitose, at length branched, 3–5 dm. tall, erect or ascending, the nodes barbed with spreading hairs, a bare ring about 1 mm. long below each node; sheaths shorter than the internodes; ligule a ring of hairs 2–5 mm. long; leaves erect, rigid, thickish, linear-lanceolate, 3–10 cm. long, 4–7 mm. wide, acuminate, rough on the margins, 7–11-nerved, the middle leaves the longest; panicle broadly ovate to orbicular, 4–6.5 cm. long, 3–7 cm. wide, its main axis somewhat pilose at the base, the remaining portion, as well as the ascending somewhat flexuous branches and their divisions, hispidulous, the lower branches 2.5–4.5 cm. long; spikelets many on hispidulous pedicels several times their length, obovate, about 2 mm. long, about 1.3 mm. broad, obtuse, the first scale about one-half as long as the spikelet, broadly ovate, acute, sparingly pubescent, 1-nerved, the second and third scales equal in length, membranous, orbicular when spread out, 9-nerved, densely pubescent with short spreading hairs, the third scale enclosing a hyaline palet about one-half its length, the fourth scale chartaceous, oval to almost orbicular, about 1.75 mm. long, enclosing a palet of equal length and similar texture.

Type specimens collected by the writer on dry somewhat shaded knolls in the grounds of the New York Botanical Garden.

It has also been secured on Staten Island, New York, by Dr. N. L. Britton; and also in southeastern Virginia, east of the Dismal Swamp and south of Great Bridge, by Dr. John K. Small.

This well-marked grass is related in habit and general appearance to *P. pubescens* Lam. and *P. villosissimum* Nash, differing from the former in the larger spikelets and the longer hairs clothing the sheaths and leaves, and from the latter in the smaller and differently shaped spikelets and in the smaller panicles.

Panicum elongatum Pursh.

The longer and acuminate spikelets serve well to distinguish this from *P. agrostoides* Muhl. Another equally important and so far constant character is the distinct stalk to the scale of the perfect flower. In *P. agrostoides* the fourth scale is sessile, or nearly so, and much broader in proportion to its length.

Dr. Geo. Vasey (Contr. U. S. Nat. Herb. 3: 35, 1892) noted this feature in what he considered an eastern form of *P. agrostoides* Spreng., and which is presumably the plant now known as *P. elongatum*.

Panicum parvispiculum n. sp.

Culms 3–5 dm. tall, caespitose, erect, or later decumbent and creeping at the base, glabrous, or toward the base appressed-hirsute, nodes blackish brown, usually more or less pubescent. Sheaths shorter than the internodes, the lower ones usually appressed-hirsute, the upper puberulent or glabrous and ciliate on the margins; ligule a copious ring of hairs 3–4 mm. long; leaves erect or ascending, rigid, thickish, linear-lanceolate, rough on the margins, glabrous above, pubescent beneath, usually with short hairs, acuminate at the apex, rounded at the base, the primary leaves 3–9 cm. long, 4–8 mm. wide, the later leaves 5–6 cm. long or less; primary panicle broadly ovate, 8–10 cm. long, its branches spreading or somewhat ascending, much divided from the base, the larger 4–6 cm. long and frequently pilose at the base; spikelets numerous, 1.5 mm. long, on divergent pedicels 1–3 times as long as the spikelets, the first three scales membranous, green, densely pubescent with short spreading hairs, the first scale one-quarter to one-third as long as the spikelet, orbicular, acute, 1-nerved, the second and third scales about equal in length, broadly oval and obtuse when spread out, 7-nerved, the third scale enclosing a hyaline palet less than one-half its length, the fourth scale chartaceous, elliptic, acutish, white, enclosing a palet of eqal length and similar texture.

Type collected by Dr. John K. Small at Darien Junction, McIntosh Co., Ga., June 25–27, 1895. It is related to *P. leucothrix* Nash, in habit, but the longer and more robust culms, the sheaths which are longer in proportion to the internodes and much less hirsute or glabrous, and the larger panicle and spikelets make manifest its specific validity.

I would also refer to this species the grass collected by Mr. A. H. Curtiss, near Jacksonville, Fla., on May 4, 1893, No. 4033, and distributed as *P. nitidum* Lam. The panicle and spikelets are somewhat smaller, but in other respects it agrees.

PANICULARIA BOREALIS n. sp.

Plant glabrous throughout. Culms 6–15 dm. tall, from a creeping base, smooth, erect; sheaths loosely embracing the culm, over-lapping, smooth or roughish, the terminal one often embracing the base of the panicle; ligule 5–15 mm. long; leaves 9–23 cm. long, 2–10 mm. wide, erect, rather abruptly acuminate, rough on both surfaces toward the apex, the upper surface also often rough throughout, the smaller leaves usually conduplicate, at least when dry; panicle, sometimes nearly simple, 1.5–5 dm. long, its main axis smooth, with the lowest internode 6–11 cm. long, branches erect, smooth, single, or in 2's or 3's, the lower bearing 3–12 spikelets 4–15 cm. long; spikelets 10–17 mm. long, 7–13-flowered, appressed, on pedicels shorter than themselves, the empty scales with a broad scarious margin, 1-nerved, smooth and shining, the first acute or obtuse, one-half as long as the second, which is obtuse and erose at the apex and one-half to two-thirds as long as the first flowering scale, flowering scales 3.5–4 mm. long, about three times as long as the internodes of the rachilla, thin, a broad scarious margin at the obtuse and erose apex, 7-nerved, the nerves hispidulous, palets hyaline, slightly shorter than the scales, narrowly elliptic, shortly 2-toothed at the obtuse apex, 2-nerved, the nerves green and narrowly winged, the wings serrulate; stamens about 1 mm. long.

In water or wet places from Maine to the Catskill Mts., N. Y., Idaho, California and Washington, and northward.

The smaller spikelets with thin flowering scales, which are hispidulous on the nerves only, clearly separate this from *P. fluitans* (L.) Kuntze, in which the flowering scales are hispidulous all over the back, and of much firmer texture.

I would refer to this the following specimens:

Fernald, Van Buren, Me., July 25, 1893, No. 193.

Nash, Cairo, N. Y., July 10, 1893.

Aiton, Idaho, June and July, 1892, No. 25.

Ballard, Swan Lake, Minn., June, 1892.

Brewer & Chickering, Geneva, N. Y., June 19, 1858.

Dr. Geo. Vasey recognized this plant as distinct from *Glyceria fluitans*, giving it the varietal name of *angustata*, but I cannot find that it was ever published. The *G. angustata* T. Fries would, however, invalidate its use in this connection.

PANICULARIA BRACHYPHYLLA n. sp.

Whole plant, except the flowering scales and a slight roughness on the branches of the panicle just below each spikelet, smooth and glabrous. Culms simple, from a decumbent and creeping base, erect, slender, 6–9 dm. tall; sheaths usually longer than the internodes, closed for nearly the entire length, striate, the uppermost one elongated, somewhat keeled toward the summit, loosely embracing the culm, and enclosing the base of the panicle; ligule 6–9 mm. long, lacerated at the apex; leaves linear, acuminate at the apex, 6–13 cm. long, 4–5 mm. wide, inclined to become conduplicate, especially when dry; panicle narrow and slender, the exserted portion 3–4 dm. long, the lower internodes of the rachis 5–7 cm. long, gradually decreasing in length to the summit, where they are 1–2 cm. in length, the branches appressed, or nearly so, the lower ones in 2's or 3's, one of which is 6–11 cm. long and bears 2–3 spikelets, the remaining one or two being much shorter and bearing a single spikelet; spikelets 2.2–3 cm. long, compressed-cylindric, 7–12-(usually 8–10) flowered, on pedicels 1–2 mm. long; empty scales of the spikelet 1-nerved, acutish, with a broad white margin, the first scale about one-half as long as the second, which is 5–6 mm. in length, the flowering scales hispidulous, 7-nerved, the lower ones a little exceeding twice the length of the internodes of the rachilla, about 5.5 mm. long, 2.5 mm. wide when spread out, elliptic, the obtuse, not truncate, apex somewhat obscurely and irregularly few-toothed; palets about 6 mm long, a little exceeding the flowering scales, acuminate, the margins infolded, the apex shortly 2-toothed, 2-nerved, the nerves wing-keeled, the wing serrulate and about .3 mm. wide in the broadest part; anthers purple, 1.5–1.7 mm. long.

Growing in water in large masses in an open swamp near the N. Y. & Harlem R. R., just north of the northern line of the grounds of the New York Botanical Garden, in company with *P. fluitans*, from which it is markedly different, the shorter and more slender culms, the shorter leaves, and the much narrower panicle readily distinguishing it; in addition to these differences, the flowering scales in *P. fluitans* are shorter (about 4 mm. long), truncate, and equal or exceed the palets. *P. brachyphylla* is really intermediate between *P. fluitans* and *P. acutiflora*, resembling the latter in habit, but at once separated from it by the smaller flowering scales, which are obtuse and not acuminate as in that species.

Robinson & Schrenk's No. 221, collected in a wet meadow at St. John's, Newfoundland, August 7, 1894, appears to be a small and simple-panicled form of this; the spikelets are fewer-flowered and the flowering scales are slightly longer, sometimes about equalling the palet, but otherwise the plant is the same.

This well-marked species doubtless occurs in other sections, but, owing to its strong resemblance in habit and general appearance to *P. acutiflora*, it has been overlooked. I should be exceedingly glad to receive more material.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 124.

Shrubs and Trees of the Southern States.I-II.

BY JOHN K. SMALL.

[Reprinted from the BULLETIN OF THE TORREY BOTANICAL CLUB, Vol. 24, No. 9, September, 1897.]

Shrubs and Trees of the Southern States.—I.

By John K. Small.

Tsuga Caroliniana Engelm. Coult. Bot. Gaz. **6**: 223. 1881.

I have already reported this rare hemlock from Georgia* and can now record a second station, at Tallulah Falls, several miles below the first one. At the second station the trees grow in a more accessible position and reach a better development, there being plenty of soil. The station is towards the lower end of the cañon, on the south side, where the bank slopes at an angle of 45° or more, and about 1000 feet above the river. Owing to a drenching rain which prevailed during my stay at Tallulah I could not ascertain the extent of this grove.

Pinus pungens Michx. f. Hist. Arb. Am. **1**: 61. *pl. 5.* 1810.

I can now report this most locally distributed of our mountain-inhabiting pines for the flora of Georgia, having encountered it in the lower part of the cañon at Tallulah Falls. For the same reason given in the foregoing paragraph, I am unable to tell the size of the grove, but it is extensive and the trees are larger than I have seen them elsewhere in the southern mountains.

Salix Wardii Bebb, Gard. & For. **8**: 363. 1895.

At the Falls of the Yadkin river in North Carolina both *Salix nigra* and *Salix Wardii* are plentiful, the black willow growing along the water's edge on the south side of the river, while *Salix*

* Bull. Torr. Club, **22**: 45.

Wardii occurs on the opposite shore hardly two hundred yards distant, the two species being respectively confined to the north and south sides of the river. The form of *Salix Wardii* occurring there is peculiar; the bushes are smaller than any heretofore observed, diffusely branched and the branches decumbent or almost prostrate, spreading radially and forming large, tangled mats, seldom rising more than six inches above the ground.

QUERCUS NANA (Marsh.) Sarg. Gard. & Forest, **8**: 93. 1895.

I was much surprised to find quantities of this scrub oak on the summit of King's and Crowder's Mountains near the southern boundary of North Carolina in the summer of 1894. The locality is within several miles of South Carolina and about one hundred miles east of the Blue Ridge.

QUERCUS RUBRA L. Sp. Pl. 996. 1753.

The existence of the red oak in Georgia was unknown to botanists before 1893. In that year I discovered a few trees just south of the North Carolina boundary, on the summit of the Thomas Bald, at an altitude of 5200 feet. The trees were stunted and irregular, as is characteristic at high altitudes. Last year, however, I found a remarkable development of the species in the northwestern corner of Georgia, in Catoosa county. The species abounds in the limestone "bottoms;" trees three feet or more in diameter are not uncommon, their trunks, naked often for seventy-five feet from the ground, are so straight that it is impossible to tell which way they will fall when cut off at the base. The thick bark is more or less mottled, whence the local name "Leopard Oak."

CELTIS MISSISSIPPIENSIS Bosc, Encycl. Agric. 7: 577. 1822.

Although extending over most of the western part of Georgia, this species of hackberry reaches its greatest development in the rich limestone "bottoms" in the region east of Lookout Mountain. Gigantic trunks, three or four feet in diameter, are very common, and are covered with innumerable corky warts, which range from one to two or even three inches in height.

DARBYA UMBELLULATA A. Gray, Am. Journ. Sci. (II.) **1**: 388. 1846.

I have lately discovered a new station for this rare plant. It grows in limited quantities on the south banks of the Yellow River, near McGuire's Mill, Gwinnett county, Georgia. I found it in company with its near relative, *Comandra umbellata*.

MAGNOLIA TRIPETALA L. Sp. Pl. Ed. 2, 756. 1763.

Another species new to the flora of Georgia, apparently never found so far southeast of the Blue Ridge. I first encountered some trees at the northern base of Stone Mountain, and later at several localities near the mountain. The trees are small and slender, and the species does not thrive as it does farther north.

CRATAEGUS ELLIPTICA Ait. Hort. Kew. **2**: 168. 1787.

On several occasions, while collecting between Tallulah Falls and Toccoa Falls and in the Nacoochee Valley in northern Georgia I have observed numerous groves of *Crataegus elliptica* growing on the barren slopes of low hills, usually above streams, at altitudes varying from 1000–1500 feet. After several seasons' study of this form in the field I can see no reason for uniting it with *Crataegus flava* as a variety, as has lately been done.* Besides characters in the habit, the leaves, the fruit and seeds, which serve to separate it specifically from *Crataegus flava*, I find an apparent trustworthy distinction in the bark of the trunk. The bark of *Crataegus flava* is black and in high narrow ridges, while that of *Crataegus elliptica* is a light brown and in thin broad scales.

CRATAEGUS ROTUNDIFOLIA (Ehrh.) Borck. in Roem. Arch **1**: Pt. 3, 87. 1798.

This species of *Crataegus* is very common in the southern Alleghanies and extends southward almost to the Gulf of Mexico. In 1895 I found it throughout the southern part of Georgia, where its favorite situation is the low ridges in the pine barrens, where the different species of hardwoods abound.

CLIFTONIA MONOPHYLLA (Lam.) Britton, Bull. Torr. Club, **16**: 310. 1889.

This curious and local plant forms remarkably dense thickets in the swamps and districts bordering streams in the vicinity of the Altamaha river, especially north of Jesup, Georgia. The

* Silva of N. A. **4**: 114.

stems there range from one-half of an inch to one foot in diameter, and the thickets they form remind one of those made by the growth of *Kalmia latifolia* and *Rhododendron maximum* on the higher mountains of North Carolina.

ACER LEUCODERME Small, Bull. Torr. Club, **22**: 367. 1895.

When first described, this species was thought to be confined to the middle country of the Southern States, but my extensive journeys in Georgia last season brought to light two new stations in the foothills of the Blue Ridge and the Alleghanies; one is the deep cañon just below the precipice of Toccoa Falls, the other a shallow cañon along the Little Chickamauga creek near Ringgold. Both stations are similar to the original, and at both the tree holds all its characters.

ACER FLORIDANUM (Chapm.) Pax, Engler's Bot. Jahrb. 7: 243. 1886.

This characteristic maple is apparently very common in the river swamps of the Flint River in southwestern Georgia Last summer I encountered a remarkable growth just below Albany. It probably follows the river to its mouth, for I again met it in the vicinity of Bainbridge. The trees are conspicuous on account of their close white bark and very dark foliage. Although said to be a small tree I measured many trunks that were three feet in diameter.

VACCINIUM HIRSUTUM Buckl. Am. Journ. Sci. 45: 175. 1844.

In April, 1893, I discovered this local and little-known huckleberry on the southern cliffs of the cañon at Tallulah Falls, Georgia. This apparently is the first collection since the original discovery by Buckley in Cherokee County, North Carolina. In 1894 Prof. A. Ruth found the shrub on the Cade's Cove Mountains in eastern Tennessee, thus adding the third station and the third State in which the species is known to exist.

Shrubs and Trees of the Southern States,—II.

By John K. Small.

I. New and Noteworthy Species.

Tsuga Caroliniana Engelm. Coult. Bot. Gaz. 6: 223. 1881.

Last fall I received specimens of this very ornamental hemlock from two new localities in North Carolina. Mr. A. M. Huger found groves of it at Banner's Elk, Watauga County, at an elevation of 1300 meters and in the Linville Gorge, Burke County, at about 575 meters above sea-level, the latter station, together with that at Tallulah Falls, Georgia, and the New River, Virginia, representing the lowest altitudes at which the species has been found.

Hicoria glabra (Mill.) Britton, Bull. Torr. Club, 15: 284. 1888.

Among the many unique things that Stone Mountain affords are some dwarf hickory trees, usually less than two meters in height, bearing quite an abundance of fruit.

Quercus minima (Sarg.)

Quercus virens var. *dentata* Chapm. Fl. S. States, 421. 1860. Not *Q. dentata* Bartr. 1794.

Quercus Virginiana var. *minima* Sarg. Silva N. A. : 101. 1895.

A low shrub forming wide patches by the extensive spreading of the underground stems. Branches erect or ascending, less than 1 meter tall, solitary or several together, simple, or branched above; leaves firm, obovate or sometimes oblong to oblanceolate, 3–10 cm. long, acute or apiculate at the apex, repand-serrate, or the upper ones sometimes entire, those of the shoots often lobed, all glabrous or finely tomentose beneath, gradually or abruptly narrowed into short petioles which vary from 2–5 mm. in length; staminate aments very slender, 1–4 cm. long, tomentose; acorns solitary or several at the ends of peduncles which vary from 1–3 cm. in length, or sometimes sessile; cups turbinate hemispheric, about 1.5 cm. broad, white-tomentose, the bracts appressed, thickened on the back, except near its edge where they form a fringe; nuts ovoid or elliptic, 1.5–1.8 cm. long, dark brown, glabrous.

Sandy sterile pine barrens, Florida, chiefly near the coast. Flowers in March and April; matures its fruit in the fall.

This peculiar oak cannot pose as a variety of *Quercus Virginiana* under any reasonable considerations. It may be of interest to note that it bears much the same relation to *Quercus Virginiana* as *Castanea nana* does to *Castanea pumila* or *Castanea dentata*. The habit of *Quercus minima*, with its underground stems, and low erect branches which are usually much less than one meter in height, is enough to separate it specifically from the gigantic forest tree *Quercus Virginiana*. In addition to the differences in habit just mentioned, the leaf types are characteristic and the nerves in the leaves of *Quercus minima* are much more prominent than they are in the live oak. The cups seem to furnish a diagnostic character, those of the *Quercus minima* being of a turbinate type, while those of *Quercus Virginiana* are hemispheric.

Quercus geminata n. sp.

A shrub or small tree, 2–5 meters tall, with a maximum trunk diameter of about 15 cm. Leaves narrowly oblong, elliptic, or oblong-oblanceolate, 3–6 cm. long, entire, obtuse or apiculate, strongly revolute, mostly gradually narrowed at the base, glabrous and parchment-like above, finely tomentose and conspicuously rugose by the prominent nerves beneath; petioles 2–6 mm.

long; flowers not seen; acorns usually 2 at the end of a peduncle, which varies from 1–4 cm. in length; cups turbinate, 1 cm. broad, tomentose, the bracts appressed, slightly thickened near the base of the cup, fringed at the edge; nuts ovoid or narrowly oval, 1–1.7 cm. long, twice or thrice as long as the cups.

Sandy soil, chiefly in the scrub, Florida. Flowers in spring and matures its fruit in the fall.

Mr. Nash, who collected and observed this plant during the seasons of 1894 and 1895, assures me that it is perfectly distinct from its relatives. This is doubtless a fact, and both the foliage and fruit furnish excellent characters. The very prominently rugose lower leaf-surfaces and the strongly revolute leaf-margins have no parallel in *Quercus Virginiana*. The acorns are always borne in pairs at the ends of short stout peduncles; the turbinate cups with their constricted bases are diagnostic.

CELTIS GEORGIANA n. sp.

A diffuse shrub with slender often 2-ranked branches, the leafy twigs more or less pubescent. Leaves ovate, 2–5 cm. long, averaging 2.5 cm. in length, or those on vigorous shoots sometimes 6 cm. long, acute, entire or sharply serrate above the middle, inequilateral, rounded or truncate at the oblique base, dark green, scabrous and occasionally sparingly pubescent above, paler and glabrous beneath, except for a few hairs on the nerves; petioles 1.5–4 mm. long, pubescent; pedicels usually slightly curved, 1.5–4 mm. long, pubescent; drupes subglobose, sometimes broader than long, 6–7 mm. in diameter, tan-color, smooth and glabrous, or sometimes glaucous; seeds obovoid-globose.

Along or near streams, north-central Georgia. Flowers in the spring; matures its fruit in September.

Collected by the writer, first in the Yellow River Valley, near McGuire's Mill, Gwinnette County, in 1893, and in succeeding years at many points about Stone Mountain and the contiguous region.

A low species related to *Celtis pumila*, from which it may be distinguished by its smaller merely acute leaves, the very short pedicels and the smaller tan-colored drupes.

CELTIS HELLERI n. sp.

A much branched, wide spreading tree, sometimes 10 meters tall with a maximum trunk diameter of 1.5 meters. Bark of the trunk and main branches with numerous corky warts; leaves rather firm, the blades ovate to oblong, 4–7 cm. long, obtuse or acute, crenate-serrate, especially above the middle, rounded or subcordate at the base, deep-green and scabrous-pubescent above, pale and tomentose beneath, slightly inequilateral, oblique at the base; petioles stout, 3–4 mm. long, tomentose; pedicels sparingly pubescent, curved, 1–1.5 cm. long; drupe subglobose, 7–9 mm. in diameter, light-brown, translucent, smooth and shining; seeds globose, strongly 4-ribbed, prominently reticulated.

In dry ground near San Antonio, Texas.

A rather low tree with a short stout trunk varying from .5–1.5 meters in diameter, and a wide spreading top. The branches are numerous and bulky. The original specimens were gathered by Mr. Heller from trees growing in a strip of woodland between the city of San Antonio and the San Antonio River, Texas, no. 1587.

TOXYLON POMIFERUM Raf. Am. Month. Mag. 2: 118. 1817.

Years ago the osage orange was planted on Paris Mountain, South Carolina, for hedges and for ornamental purposes. For many years the settlements have been neglected and deserted and the tree has spread and established itself in an astonishing manner, now appearing as if indigenous.

ALBIZZIA JULIBRISSIN Durazz. Mag. Tosc. 3: 11. 1772.

Although not indigenous, this tree now appears as if it were native in the southern states. It grows along roadsides and here and there through the pine woods much as the honey locust (*Gleditsia triacanthos*) does in many localities. It ranges from North Carolina to Georgia, Florida and Alabama, where Prof. Underwood collected specimens during the past summer. It is quite abundant in southern Georgia.

AMORPHA VIRGATA Small, Bull. Torr. Club, 21: 17. *pl. 171.* 1894.

In the spring of 1896 Dr. Charles Mohr sent me a specimen of *Amorpha virgata* from the mountains of Madison county, Alabama, thus extending the known geographic range of the species from Stone Mountain, Georgia, to northern Alabama. Dr. Mohr gives the altitude of this locality as 350 meters. While collecting at different points along the eastern section of the Blue Ridge during the summer of 1896, I was surprised to find the species both on the slopes and summit of Paris Mountain near Greenville, and on the slopes of Table Mountain. At the former locality it occurred at an altitude of about 500 metres, and on Table Mountain it ranged from 800–900 meters. Its characters hold perfectly.

LONICERA FLAVA Sims. Bot. Mag., *pl. 1318.* 1810.

About two years ago I recorded* several new localities for this handsome honeysuckle. Further exploration of the southern end of the Blue Ridge has revealed additional stations. In the summer of 1894 I found some bushes on the upper slopes of Currahee Mountain, an isolated peak near Toccoa, Georgia, and a little later noticed several bushes on Stone Mountain. During the past summer I collected it on Paris Mountain, South Carolina, the original locality, where it grows at several points along the rocky summit, and later discovered a new station on the precipitous cliffs of Table Mountain, in the same state. At the latter place the shrubs were more robust and vigorous than at any of the other stations.

The finest flowering specimens I have ever seen were sent me by Mr. A. M. Huger, who secured them on Tyron Mountain, Polk County, North Carolina, last spring. Mr. Huger's discovery extends the range of the species into another state, but although we now have specimens showing the species to range from North Carolina to Georgia, it is not common at any of the localities, a few bushes only existing at the different places.

II. THE GENUS GAYLUSSACIA IN THE SOUTHERN STATES.

During several seasons I have had ample opportunity to study this imperfectly understood group in the field and have made observations on all except one of the species recognized in the appended revision. As far as I can see, the forms hitherto considered as varieties of other species are abundantly distinct and should be treated as species. Mr. Nash came to the same conclusion during his field-work in Florida. The diagnostic characters are brought out in the following key and descriptions.

* Bull. Torr. Club, 21: 305.

Corolla campanulate or globose campanulate; leaves destitute of sticky resin.
  Stems horizontal, underground, the branches erect.
    Pubescence consisting of gland-tipped hairs.
      Twigs and racemes pilose. — 1. *G. dumosa.*
      Twigs and racemes bristly-hispid. — 2. *G. hirtella.*
    Pubescence consisting of simple non-glandular hairs.
      Leaves glaucous, glabrous or nearly so. — 3. *G. nana.*
      Leaves densely tomentose, especially beneath. — 4. *G. tomentosa.*
  Stems erect, the branches spreading.
    Leaves leathery, obtuse or retuse; drupe glaucous. — 5. *G. frondosa.*
    Leaves thin, acuminate and apiculate; drupe black. — 6. *G. ursina.*
Corolla conic; leaves sticky with a resinous secretion. — 7. *G. resinosa.*

1. Gaylussacia dumosa (Andr.) T. & G.

Vaccinium dumosum Andr. Bot. Rep. **8**: 112. 1794.

Gaylussacia dumosa T. & G.; A. Gray, Man. 259. 1848.

A low shrub, 1–5 dm. tall, with underground stems and erect solitary or tufted branches; the twigs, leaves and inflorescence glandular-pilose. Leaves leathery, the blades oval, obovate or oblanceolate, rarely linear-oblanceolate, 2–4 cm. long, apiculate at the apex, ciliate, short-petioled, deep green above, paler beneath; calyx glandular, about 5 mm. broad, the segments triangular or triangular ovate, acute, about as long as the tube; corolla campanulate, 5–6 mm. long, white or pink, wax-like, the segments broadly ovate, more or less recurved and revolute; filaments short, pubescent; anthers longer than the filaments, prolonged into filiform tubes; drupe globose, black, 6–8 mm. in diameter, commonly somewhat pubescent.

In sandy soil, Newfoundland and along the coast to New York, south to eastern Pennsylvania, North Carolina, Florida and Louisiana. Spring; matures its fruit in the summer.

2. Gaylussacia hirtella (Ait.) Klotzsch.

Vaccinium hirtellum Ait. Hort. Kew. Ed. 2. **2**: 357. 1811.

Gaylussacia hirtella Klotzsch, Linnaea, **14**: 48. 1840.

Gaylussacia dumosa var. *hirtella* A. Gray, Man. 259. 1848.

A shrub, with underground stems, the branches, twigs and inflorescence bristly-hispid, the tips of the hairs with minute glands; leaves firm, the blades oblanceolate-spatulate or elliptic, 3–6 cm. long, apiculate, glandular-ciliate sparingly hispid above, short-petioled; racemes many-flowered; calyx hispid, 6 mm. broad, the segments triangular, rather acuminate, about as long as the tube; corolla broadly campanulate, 7–8 mm. long, the segments broader than long, the tips recurved, the edges revolute; filaments short, pubescent; anthers longer than the filaments, prolonged into filiform tubes; drupe not seen.

In sand, Florida to Louisiana. Spring; fruit ripe in the summer.

Certainly distinct from *Gaylussacia dumosa*, from which it differs in habit, size and leaf characters. The pubescence is always diagnostic, the corolla is larger and much thinner than that of *G. dumosa*, while the calyx-segments are longer and usually acuminate.

3. Gaylussacia nana (A. Gray).

Gaylussacia frondosa var. *nana* A. Gray, Syn. Fl. N. A. Ed. 2. 2: Pt. 1, 396. 1886.

A low glaucous shrub 1–4 dm. tall, spreading by underground stems. Leaves leathery, the blades elliptic, obovate or nearly spatulate, 2–3 cm. long, obtuse or minutely apiculate at the apex, glaucous on both sides, becoming bright green above, prominently rugose and sprinkled with amber-colored resin beneath, short-petioled; racemes few-flowered; pedicels slender, puberulent when young; calyx glabrous, 3 mm. broad, the segments triangular, acute, about as long as the tube; corolla globose-campanulate, 3 mm. long, the segments ovate, acutish, longer than broad; filaments short, glabrous; anthers longer than the filaments, prolonged into slender tubes; drupes subglobose, 6–7 mm. in diameter, rather dry, glaucous.

In sandy pine barrens, Georgia to Florida and Alabama. March to April; matures its fruit in the summer.

Easily distinguished from *Gaylussacia frondosa*, with which it has been associated, by its very glaucous foliage and strongly rugose and much smaller leaves, besides its peculiar underground stems.

4. Gaylussacia tomentosa Pursh.

Gaylussacia frondosa var. *tomentosa* A. Gray. Syn. Fl. N. A. 2: Pt. 1, 19. 1878.

Gaylussacia tomentosa Pursh; A. Gray. Syn. Fl. N. A. 2: Pt. 1, 19. As synonym. 1878.

A low shrub, spreading by underground stems, the foliage tomentose with brownish hairs. Leaves leathery, the blades oblong or elliptic, often slightly broadest above the middle, 2.5–7 cm. long, obtuse and apiculate at the apex or sometimes notched, brown-tomentose on both sides, densely so beneath, short-petioled;

racemes few-flowered; pedicels 1–1.5 cm. long, much longer than the bracts; calyx glabrous, about 3.5 mm. broad, the segments ovate, acute, about as long as the tube; corolla campanulate, 3.5 mm. long, the segments ovate, obtuse, about as long as broad, the tips recurved, the edges revolute; filaments dilated, glabrous; anthers longer than the filaments, prolonged into slender tubes; drupes depressed-globose, 8–9 mm. in diameter, glaucous.

In sandy soil, Georgia and Florida. Spring; matures its fruit in the summer.

Like the preceding species, *Gaylussacia tomentosa* has underground stems, but it differs from it in the brown-tomentose foliage, more robust habit, larger leaves and different leaf-form. The fruit of *G. tomentosa* is larger and much more fleshy than that of *G. nana*.

5. Gaylussacia frondosa (L.) T. & G.

Vaccinium frondosum L. Sp. Pl. 351. 1753.

Gaylussacia frondosa T. & G.; Torr. Fl. N. Y., 1: 449. 1843.

An irregularly branched shrub 1–2 meters tall, with puberulent twigs and young leaves. Leaves firm, the blades oblong-oblanceolate, ovate, oval or obovate, obtuse or notched at the apex, delicately revolute, short-petioled, bright green and glabrate above, glaucous and sprinkled with minute golden globules of resin beneath; racemes loose; pedicels long and slender; calyx glabrous, 3–4 cm. broad, the segments triangular, acute or acutish, about as long as the tube; corolla globose-campanulate, about 4 mm. long, green to purplish, the segments triangular, broader than long, recurved and revolute; filaments dilated, glabrous; anthers longer than the filaments, prolonged into slender tubes; drupe globose, 8–10 mm. in diameter, with a pale bloom.

In sandy soil, New Hampshire, south to Florida, Kentucky and Louisiana. Spring; matures its fruit in the summer.

6. Gaylussacia ursina (M. A. Curtis) T. & G.

Vaccinium ursinum M. A. Curtis, Am. Journ. Sci. 44: 82. 1843.

Gaylussacia ursina T. & G.; A. Gray, Mem. Am. Acad. (II.) 3: 49. 1846.

A straggling branching shrub, 6–15 dm. tall, with sparingly pubescent twigs and young foliage. Leaves thin, the blades oblong, elliptic or oblanceolate, usually rhomboidal, 4–10cm. long, usually short-acuminate; apiculate, ciliate, deep green above, paler beneath, pubescent on the nerves on both sides, obtuse or rounded at the base, short-petioled; flowers few, in lateral somewhat drooping racemes; calyx with numerous golden glands, about 3 mm.

broad, its 5 segments very low, obtuse, several times shorter than the tube; corolla globose-campanulate, greenish-white or tawny-red, about 4–5 mm. long, its segments triangular, acutish, recurved, revolute; filaments dilated, pubescent, incurved at the apex, longer than the anthers which have short tubes at the apex; drupe globose, 10–12 mm. in diameter, black, shining, sweet.

In deep forests on the mountains, North Carolina to northern Georgia. Spring; matures its fruit in the late summer.

7. Gaylussacia resinosa (Ait.) T. & G.

Vaccinium resinosum Ait. Hort. Kew. 2: 12. 1789.

Gaylussacia resinosa T. & G.; Torr. Fl. N. Y. 1: 449. 1843.

A rigid branching shrub 3–12 dm. tall, its twigs and foliage more or less pubescent and sticky with a resinous secretion when young, leaves firm, the blades elliptic, oval or oblong, sometimes broadest above the middle, firm, obtuse or apiculate, entire, ciliolate, short petioled; flowers in lateral drooping racemes; pedicels 2–8 mm. long, usually with two narrow bracts; calyx about 2 mm. broad, its 5 segments ovate, obtuse, about as long as the tube; corolla obconic, red or reddish-green, 5–6 mm. long, more or less constricted near the apex, the segments ovate, spreading or recurved, revolute, obtuse; filaments winged, pubescent, shorter than the anthers, each cavity of which is prolonged into a tube; drupes globose, 6–10 mm. in diameter, black or rarely white, sweet.

In rocky woods and hillsides, Newfoundland to the Saskatchewan, south to Georgia. Spring; matures its fruit in the summer.

CONTRIBUTIONS FROM THE DEPARTMENT OF BOTANY OF COLUMBIA UNIVERSITY.—No. 125.

Studies in the Botany of the Southeastern United States.—XII.

BY JOHN K. SMALL.

(PLATE 315.)

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Studies in the Botany of the Southeastern United States.—XII.

By John K. Small.

(Plate 315.)

I. Noteworthy Species.

Tradescantia montana Shuttl.; Britton, in Britton & Brown, Ill. Fl. 1: 377. *fig. 911.* 1896.

Mr. C. D. Beadle has distributed specimens of this Alleghenian *Tradescantia* from the Biltmore Herbarium, which match the original specimens of Rugel more closely than any others that I have seen. The plants from Biltmore are somewhat larger and more advanced than the specimens on which the species was founded but come from the same general region. The original specimens are accompanied by the following record: "In pre-eruptis reg. med. mont. Broad River Ms., Carolina Sept. legit Rugel, Jun. 1841.

Sisyrinchium graminoides Bicknell, Bull. Torr. Club, 23: 133. 1896.

After describing this *Sisyrinchium* Mr. Bicknell gives a general distribution for the species, but notes the "exact distribution not well made out." I can now record two definite southern stations: the first, Stone Mountain, Georgia, where I collected the plant at an altitude of about 550 meters, in 1895, and Auburn, Alabama, where Prof. Underwood gathered specimens in 1896.

Oxalis grandis Small, Bull. Torr. Club, 21: 474. 1894.

Mr. C. D. Beadle has lately sent me specimens of this, our most robust species of *Oxalis*, from the Biltmore herbarium, collected in thickets at Biltmore, North Carolina. This collection extends the geographic range of the species somewhat further southward than was heretofore known.

OXALIS RECURVA Ell. Bot. S. C. & Ga. **1**: 526. 1821.

As the exploration of the Southern States progresses, Elliott's beautiful and delicate recurved-styled *Oxalis* is being found at various points. Mr. Beadle has sent me ample specimens, showing the extensive rootstock system, and the first specimens gathered bearing mature fruit. The species grows in woodlands at Biltmore.

HEDERA HELIX L. Sp. Pl. 202. 1753.

The common European ivy must be admitted to the flora of the Southern States as an introduced species. It is frequent about old dwellings and similar places and I have found it perfectly naturalized on the steep, rocky banks of the Ocmulgee River, above Macon, Georgia, where it has escaped from a cemetery higher up on the hill.

LIMONIUM AUGUSTATUM (A. Gray).

Statice Brasiliense var. *augustata* A. Gray, Syn. Fl. **2**: part 1, 54. 1878.

Perennial, slender, acaulescent; leaves basal, few, the blades linear, 4–7 cm. long, cuspidate, 1-nerved, narrowed into petioles which are somewhat shorter than the blades, their bases dilated; scapes erect, about 3 dm. tall, with several scale-like clasping bracts, sparingly branched above; bracts subtending the flowers broadly oblong, 4 mm. long, acute; calyx about 5 mm. long, the tube glabrous, the 5 teeth ovate, the connecting membranes eroded.

In salt marshes, Pine Key, Florida.

The best treatment of our North American *Limonia* that has thus far appeared is that by Dr. Gray in his Synoptical Flora, **2**: Part 1, 54; but one distinct species was there admitted as a variety and one was overlooked. (See page 491.)

The plant just described is apparently rare and I call attention to it hoping that some of the botanists of southern Florida may be able to find it and collect specimens. Heretofore it has been made a variety of *Limonium Brasiliense* (Boiss.) (*Statice Brasiliensis*

Boiss.), but is readily distinguished by its more slender habit, the linear leaf-blades, the oblong acute bracts which subtend the flowers, and the ovate calyx-segments.

GENTIANA QUINQUEFOLIA L. Sp. Pl. 230. 1753.

Mr. A. M. Huger has sent me specimens of this gentian from the vicinity of Waynesville, North Carolina, noting that the plants often produce a prodigious number of flowers, he having counted over three hundred and sixty on some specimens. He has also observed the extensive altitudinal range of the species, recording that it grows from the "bottoms" to "balds," in this case from about 300 meters to nearly 1500 meters. I have noticed the same occurrence in northern Georgia.

IPOMOEA BARBIGERA Sweet, Brit. Fl. Gard. *pl. 86.* 1818.

Dr. Mohr has lately published an interesting note on this species in this journal;* the plant has apparently not been collected many times since its discovery and it would be desirable to know more of its geographic range. Prof. Carl F. Baker has sent me specimens collected near Auburn, Alabama, in the fall of 1896.

IPOMOEA PURPUREA (L.) Roth, Bot. Abh. 27. 1787.

Prof. Baker has also sent me this morning glory, collected near Auburn, Alabama, thus giving us a station between the Atlantic States and Texas; this break in its range is indicated in the Synoptical Flora.†

MENTHA ROTUNDIFOLIA (L.) Huds. Fl. Angl. 221. 1762.

Only one station in the Southern States, namely, "near Wilmington, North Carolina,"‡ has been recorded for this mint. However the species is spreading; in 1891 Miss K. A. Taylor collected specimens in a wet meadow near Columbia, South Carolina, and in 1895 I found it abundant near Trader's Hill in southeastern Georgia.

* Bull. Torr. Club, 24: 26.

† Syn. Fl. N. A. 2: 210.

‡ Chapm. Fl. S. St. Ed. 2. 313.

Teucrium Nashii Kearney, Bull. Torr. Club, 21: 483. 1894.

Mr. A. H. Curtiss has added another station for *Teucrium Nashii*. The specimens are from near Jacksonville, Florida, and are numbered 5040.

Lonicera Japonica Thunb. Fl. Jap. 89. 1784.

In a former note * I have spoken of the abundance of this foreign plant in certain localities. Mr. A. H. Curtiss now sends it from Florida (number 4690) saying, "In moist thickets where this gets a foothold it grows and fruits more freely than does *L. sempervirens* on dry land. I do not know that either grow from seed." I may add that it has become a very troublesome weed in many parts of the country.

II. New Species.

Vicia Hugeri.

Annual, very slender, bright green, minutely and sparsely pubescent, or glabrate in age. Stems ascending, decumbent or reclining, solitary or several together, 3–7 dm. long, wire-like, more or less angled, sometimes branched above, rarely branched below; leaves 4–8 cm. long, the tendril simple or forked; leaflets usually 10–12, linear, 2–3.5 cm. long, mucronulate, straight or slightly curved, short-petioled; peduncles 5–8 cm. long, ascending; flowers white or sometimes pinkish, 10–14 in secund racemes, small; pedicels 1.5–2 mm. long; calyx campanulate, 1.5 mm. long, the teeth triangular, ¼–⅓ as long as the tube, acute; corolla about 5 mm. long; pods linear-oblong, 2 cm. long.

In open woods, Georgia and Alabama. March to May.

Lately several specimens of this peculiar species of *Vicia* have reached me from different points in the Southern States. The plant first came to my notice on the slopes of Stone Mountain, Georgia, in 1895. The species stands between *Vicia Caroliniana* and *V. micrantha*, possessing the general habit of the latter and the inflorescence of the former.

From *Vicia micantha* it differs in its elongated many-flowered racemes, longer peduncles and glabrous or glabrate calyx with the segments as broad as long or broader, while from *Vicia Caroliniana* it can easily be distinguished by its more slender habit,

* Bull. Torr. Club.

narrower leaves and the smaller flowers, these being hardly one-half as large as those of *Vicia Caroliniana.* I take pleasure in naming the species for my friend Mr. A. M. Huger, a very thorough explorer of the flora of the Southern States. I have specimens before me as follows:

Georgia: Stone Mountain, May 1–18, 1895, J. K. Small; Americus, March 1, 1897; Atlanta, April, 1897, and Gainesville, April, 1897, A. M. Huger.

Alabama: Auburn, March 28 and April 18, 1896, L. M. Underwood and F. S. Earle.

SAMOLUS CUNEATUS.

Perennial, fleshy. Stems solitary or tufted, 1–3 dm. long, ascending or reclining, simple or usually branched; leaves opposite or mainly so, obdeltoid-spatulate or broadly spatulate, 4–12 cm. long, truncate or coarsely mucronate at the apex, the bases decurrent as broad wings; racemes 1–3 dm. long, their peduncles longer than the stems, together with the racemes glandular-pilose; pedicels slender, spreading or ascending, 1–3 cm. long; calyx campanulate, the triangular acute segments longer than the tube, or at maturity shorter; corolla white, 4–5 mm. broad, the 5 lobes broadly cuneate, flattish or truncate at the apex, toothed, as long as the tube; stamens included; capsules depressed-globose, 3–3.5 mm. in diameter; seeds .4 mm. thick.

On limestone rocks or soil, Texas. Spring.

A study of the genus *Samolus* has revealed this hitherto undescribed species; it is related to *Samolus alyssoides* and *S. ebracteatus*, from both of which it may be distinguished by the glandular-pilose peduncles and smaller corollas. The corollas of specimens of *Samolus alyssoides* and *S. ebracteatus* which I have examined vary from 6–9 mm. in breadth, while those of *S. cuneatus* are only 4–5 mm. broad. The corolla-segments of the new species are broadly cuneate as contrasted with the suborbicular segments of the two older ones.

The following specimens belong to *S. cuneatus:*

Texas: Kerrville, Kerr county, May 14–21, 1894, A. A. Heller, no. 1751 (type); Waco, 1887, Miss Sara Trimble.

LIMONIUM NASHII.

Perennial by branching rootstocks, glabrous. Leaves basal, the blades oblong or elliptic, sometimes varying to narrowly obovate, 4–10 cm. long, rounded or notched at the apex, occasionally mucronate, narrowed into petioles which are shorter than the blades or longer; scapes erect, 3–7 dm. tall, furnished with scale-like bracts, widely branching above, the tips of the spreading branches recurved; bracts subtending the flowers oval, about 4 mm. long, obtuse; calyx 6–7 mm. long, the tube sparingly pubescent with soft hairs at the base only, the 5 segments triangular, slightly acuminate, more than 1 mm. long; corolla deep blue.

In salt marshes, Florida. Summer and fall.

Specimens of a beautiful and previously undescribed species of *Limonium* have been in our herbaria for some years; they are from northern and eastern Florida and represent a species of more slender and more graceful habit than that of *Limonium Carolinianum.*

The following synopsis and comparison of the diagnostic characters of *Limonium Nashii* and *L. Carolinianum* will serve to make clear the difference between the two species:

Limonium Nashii. Branches of the panicle spreading, the tips recurved; bracts subtending the flowers oval; calyx-tube sparingly pubescent at the base; calyx-segments triangular, slightly acuminate.

Limonium Carolinianum. Branches of the panicle ascending, the tips curved upward; bracts subtending the flowers suborbicular; calyx-tube bristly-pubescent; calyx-segments ovate.

The species has been collected as follows:

Florida: Chapman; St. Marks, Aug. 1843, Rugel; Titusville, Brevard County, July 31, 1895, Nash. no. 2305.

Eupatorium petalodium Britton.

Perennial, bright green. Stems erect, 3–7 dm. tall, simple below, corymbosely branched above, somewhat rough with rigid hairs; leaves mainly opposite (a few of the upper ones alternate), oblong to lanceolate, 2–8 cm. long, obtuse or rarely acutish, bluntly serrate or crenate-serrate, except the entire more or less cuneate base, glabrous or sparingly pubescent on the nerves beneath, sessile; peduncles and pedicels pilose; involucres trumpet-shaped, 9–10 mm. high, the bracts linear-spatulate, the outer ones abruptly acuminate, the inner ones mucronate, slightly surpassing the flowers, petal-like, white; corolla 3 mm. long, the segments ovate, spreading; pappus about equalling the corolla; styles exserted; achenes black, nearly 3 mm. long, 5-angled.

In dry pine barrens, Florida. Summer and fall.

Florida: Chapman; Duval County, N. E. Florida, Curtiss, no. 1190; near Jacksonville, Curtiss, nos. 4437 and 5162.

A showy species hitherto confused with *Eupatorium album* and not yet found without the State of Florida. The general habit of the species is that of its nearest relative, *E. album*, but in place of an acute leaf-blade there is an obtuse apex. However, the crucial character lies in the inner involucral bracts; these, instead of being long-acuminate, are linear-spatulate and conspicuously mucronate, the dilated portions of a white or creamy-white color.

Chrysopsis Ruthii.

Perennial, slender, silvery-pubescent, stoloniferous. Stems diffusely branched, 1–3 dm. long, the branches ascending or decumbent, very leafy, densely so above; leaves linear or some linear-lanceolate, 2–5 cm. long, acuminate, entire, sessile, the old ones becoming longitudinally ribbed; heads solitary, or corymbosely disposed, about 1 cm. high; peduncles 1.5–2 cm. long, densely glandular; involucral bracts linear or linear-lanceolate, in 4–5 series, glandular on the back, the pale edges ciliate, the apex bearded; rays bright yellow, elliptic-spatulate, 7–8 mm. long, slightly notched at the apex; corolla 5 mm. long, yellow, the segments triangular, sparingly ciliate, nearly erect; pappus dirty white, slightly shorter than the corolla; filaments and anthers glabrous; style glabrous, except the very sparingly glandular top; achenes pubescent.

Rocks in the Hiawassee Valley, eastern Tennessee.

A low stoloniferous species related to *Chrysopsis graminifolia* from which it differs conspicuously in being low, diffusely branched and bushy. Besides the very slender habit, the small acuminate leaves, the glandular peduncles and narrower and more acuminate involucral bracts distinguish *Chrysopsis Ruthii* from *C. graminifolia*. The species is named for Prof. A. Ruth, of Knoxville, Tenn.

Silphium Mohrii.

Perennial, coarse, very hispid throughout with shaggy hairs. Stem erect, 6–12 dm. tall, simple below, branched above, finely channelled in age; leaves alternate, ovate-lanceolate to narrowly ovate, 5–14 cm. long, acuminate, remotely serrate with prominent teeth, except near the base and apex, sessile or nearly so; heads 3.5–4.5 cm. broad, peduncled; involucres broadly campanulate, the bracts lanceolate or ovate-lanceolate, 8–14 mm. long, acute or somewhat acuminate; corolla about 4 mm. long, the segments ovate, rather obtuse; rays yellow, elliptic-oblong, 10–14 mm. long, undulately 3-toothed at the apex; achenes obovate, more or less constricted at both ends, about 6 mm. long, winged (Plate 315).

In dry or rocky soil, Cullman, Alabama, October, 1885.

A very distinct species of the confused genus *Silphium*, related to what I take to be *S. asperrimum* Hook., hitherto usually called *S. scaberrimum*. It is at once distinguished by the copious shaggy pubescence of its foliage as against the short retrorse pubescence of its relative. The peculiarly toothed leaves with their less rounded bases, and the smaller heads with their narrower bracts and shorter rays are additional distinguishing characters.

The species is named in honor of the veteran botanist of Alabama, Dr. Charles Mohr, who for many years has furnished our collections with rare and unique plants from that interesting region.

III. The True Position of Viola tripartita Ell.

The record of the occurrence of *Viola hastata* in Florida has always been a puzzle to me, for that plant is as typical an Alleghenian species as our flora affords.

During my field work in the Southern States I have had opportunity to study the forms under consideration in their native habitats and have been led to the following conclusions, namely: That *V. tripartita* is specifically distinct from its relatives, and that it is closely related to *V. pubescens* and *V. scabriuscula* and not to *V. hastata*. It seems strange that Dr. Gray, and even the sagacious Le Conte failed to observe the latter fact, for a casual glance at the foliage and flowers is sufficient to prove this position correct, the sepals and petals of *V. tripartita* being much more similar to those of *V. pubescens* than to those of *V. hastata*.

The question that naturally arises is: How was *V. tripartita* ever confounded with *V. hastata*? As far as I can see this was brought about through observations on simple-leaved plants of *V. tripartita*; it is on simple-leaved specimens of this plant that *V. hastata* is admitted to the flora of Florida. The leaf form of the latter species is so distinct and unique that it need not be further considered in this connection. On the other hand the leaf form of *V. tripartita* in its simple state, which is quite frequent, closely resembles that of *V. pubescens* but differs in size, shape, proportionate width and length and the toothing. It may be of interest to note that I have seen the type of *V. tripartita* on several occasions and have collected specimens almost identical with it on Stone Mountain, which is no great distance from the original locality, Athens, Georgia. I have also received excellent and typical specimens from Mr. A. M. Huger, collected in Polk County, North Carolina, and a series of specimens showing all degrees of gradation from the simple-leaved state to the trifoliolate leaf, from Mr. E. R. Memminger, who independently came to the conclusion that the affinities of *V. tripartita* are with *V. pubescens* and not with *V. hastata*.

I append a description taken from living plants.

VIOLA TRIPARTITA Ell. Bot. S. C. & Ga. 1: 320. 1817.

Viola hastata var. *tripartita* A. Gray, Bot. Gaz. 11: 291. 1886.

Perennial by a short rootstock and numerous coarse roots, usually stoutish, puberulent or minutely pilose and glandular above, bright but often deep green. Stems mostly clustered, erect, 1.5–5 dm. tall, usually branched above, often purplish and glabrate below, greenish, glandular, and somewhat glandular near the top; leaves 3-parted or sometimes entire, 4–10 cm. long, their petioles 2–3 cm. long; stipules ovate, ciliate, 6–8 mm. long; leaflets usually short-petioled, puberulent, undulate or crenate-serrate, the terminal one lanceolate or oblanceolate, the lateral ones inequilateral lanceolate to ovate; flowers golden yellow, 1.2–1.5 cm. broad; pedicels slender, nearly erect, 3–10 cm. long; sepals lanceolate or oblong-lanceolate, nearly 6 mm. long, 3-ribbed, acute or obtuse, with hyaline ciliolate margins; petals spatulate, about 1 cm. long, the upper ones recurved, purplish on the back, with one conspicuous black vein, the lateral ones with two black veins and a patch of glands, the lower one with numerous conspicuous black veins; stigma bearded; capsule oblong, 1–1.2 cm. long, acutish; seeds pale, obovoid, 3 mm. long.

IV. MELOTHRIA GRANDIFOLIA T. & G., AND ITS TRUE POSITION.

Melothria grandifolia, published by Torrey and Gray in 1840, soon disappeared from the pages of succeeding botanical works and in Prof. Cogniaux's Monograph of the Cucurbitaceae* we find the name in an appended list of doubtful species. The apparent rarity of the species, or at least the scarcity of speci-

* DC. Monog. Phanerog. 3: 948.

mens in herbaria may account for the way in which the plant was excluded from botanical literature by later authors; an examination of the original specimens of the plant in question, however, shows that it is not a *Melothria* in the modern sense and hereafter may be known as

CAYAPONIA GRANDIFOLIA (T. & G.).

Melothria grandifolia T. & G. Fl. N. A. 1: 541. 1840.

The species is closely related to *Cayaponia Boykinii* of the Southern States, but differs in the more robust habit, the larger leaves and in the larger and more elongated fruit.

SILPHIUM MOHRII SMALL