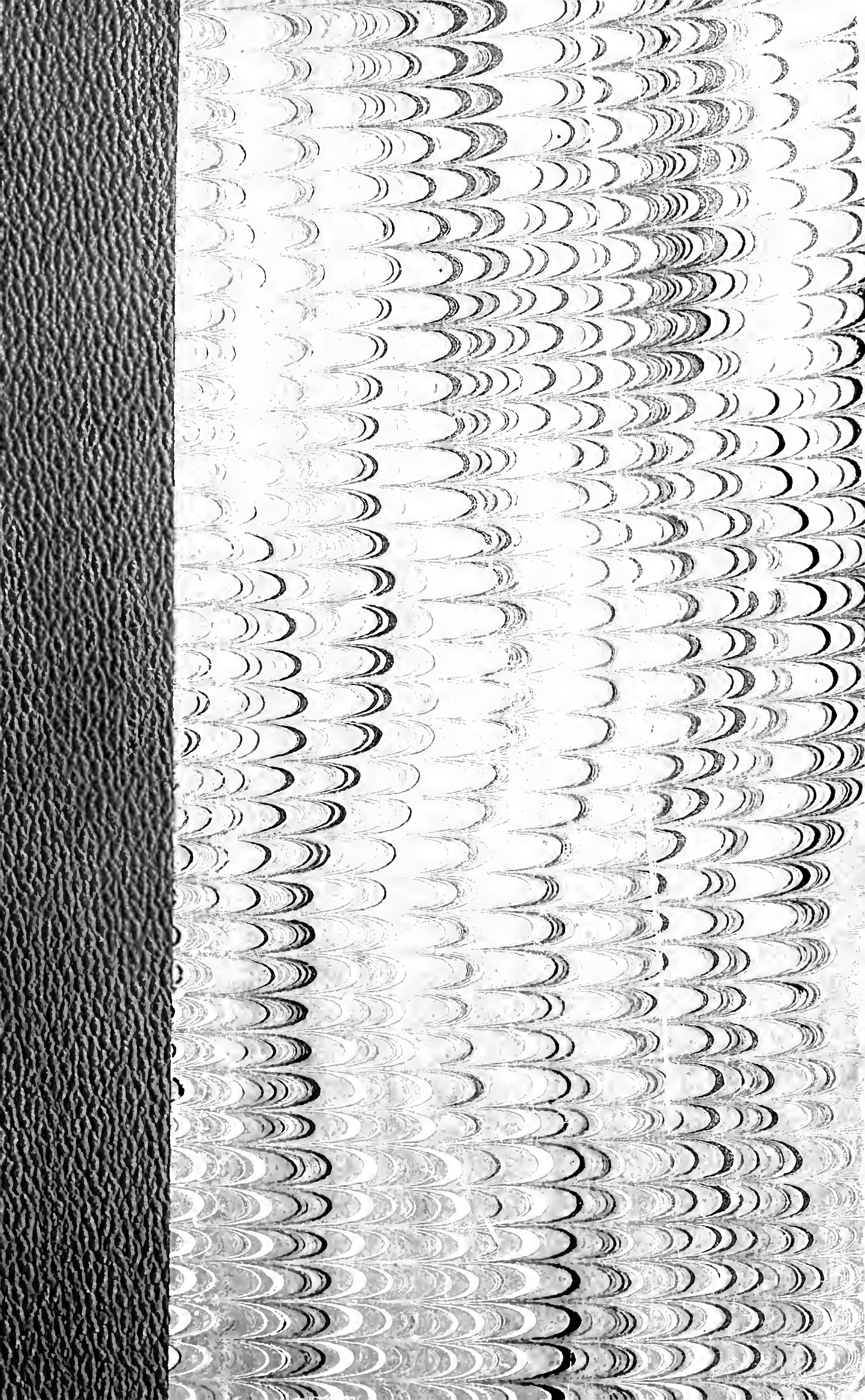

THE

TRANSACTIONS

OF THE

ACADEMY OF SCIENCE

OF ST. LOUIS.

Vol. V.

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TRANSACTIONS.

A Spiral on a Torus.

By J. H. KINEALY.

Last September I showed to the Academy a model of a stove-pipe elbow that had been made of a single strip of tin wound so that there was only one joint. This joint was a continuous spiral around the elbow. The spiral joint had not been made according to any law, but had simply been guessed at. This elbow had been made by Mr. E. F. O'Toole, a tinner living in the northern part of this city, who, when he gave it to me, asked if it would be possible to make a spiral that would be the same in all parts similarly situated.

In order to show me the spiral he wished, he took a helical wire-spring and bent it so as to form a quadrant. I saw at once that the spiral wanted was a spiral on a torus, which, when the radius of the circular axis of the torus was equal to infinity, became a helix.

I then attempted to generate a spiral on a torus by moving a point on the surface of the torus so that the tangent to the curve would always make a given angle with the circular axis of the torus. This, however, involved a very difficult differential equation. After some further study I found that a spiral could be generated upon any surface by the following method:

Let the surface upon which the spiral is to be drawn be generated by a curve in a plane that revolves about a given axis with an uniform angular velocity. Let the point by which the spiral is generated always remain on the generating curve and move about an axis, perpendicular to the moving plane, with an uniform angular velocity.

The axis first mentioned will be called the axis of the generating curve; and the last, the axis of the point.

It is evident, that, if the equation of the curve traced by the axis of the point is known, and, also, the equation of the generating curve, referred to the axis of the point as an origin, the equation of the spiral can at once be determined.

In Fig. I. the plane of yx is the plane of the paper, and the axis of z is taken perpendicular to yx.

OT is the trace of the moving plane on yx at a given time. It revolves about the axis of z with an uniform angular velocity.

The initial position of the plane OT is zy. The projection of the generating curve on yx is ace.

In order to simplify the equation it is supposed that the curve traced by the axis c of the point is a plane curve (bcd) on yx.

P' is the projection on yx of the point at the given instant.

The point was in its initial position on yx when OT coincided with Oy.

Revolve the moving plane about OT as an axis until it falls on yx.

Let aPe be the revolved position of the generating curve, and P that of the point.

Draw $P'm$ perpendicular to Oy; also draw Pc and PP'.

Let α be the angular velocity with which the plane moves about Oz, and α' the angular velocity with which the point moves about c.

If t is the time the plane has heen moving,

$$\angle\, TOy = a = t.\alpha.$$

$$\angle\, Pce = \theta = t.\alpha'.$$

$$t = \frac{a}{\alpha} = \frac{\theta}{\alpha'}, \text{ or } \theta = \frac{\alpha'}{\alpha} a = n\, a,$$ where n is a constant equal to $\frac{\alpha'}{\alpha}$.

$$x = P'm = OP' \sin a = [Oc + cP \cos\theta] \sin a$$
$$y = mO = OP \cos a = [Oc + cP \cos\theta] \cos a$$
$$z = PP' = cP \sin\theta.$$

Oc depends upon the curve bcd, and cP upon the curve aPe.

Therefore,

$$Oc = f(xya) \text{ and } cP = f(yz\theta).$$

Putting these values in the equations above, and also putting na for θ, the general equations for the spiral become

$$x = [f(xya) + f(yzna) \cos na] \sin a \quad - \quad - \quad - \quad (1)$$

$$y = [f(xya) + f(yzna) \cos na] \cos a \quad - \quad - \quad - \quad (2)$$

$$z = f(yzna) \sin na \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad (3)$$

If $f(xya) = R$, a constant, and $f(yzna) = r$, also a constant, the curve traced by c is a circle whose center is at O; and the generating curve is also a circle with its center at c,—the general equations become

$$x = [R + r \cos na] \sin a \quad - \quad - \quad - \quad - \quad - \quad - \quad (4)$$

$$y = [R + r \cos na] \cos a \quad - \quad - \quad - \quad - \quad - \quad - \quad (5)$$

$$z = r \sin na \quad - \quad - \quad - \quad - \quad . \quad - \quad - \quad - \quad - \quad (6)$$

These are the equations of the spiral on a torus.

The projection of such a spiral on the plane yx is shown in Fig. II. The equation for this projection is obtained by squaring (4) and (5), and adding. It is

$$x^2 + y^2 = [R + r \cos a]^2 \quad - \quad - \quad - \quad - \quad - \quad - \quad (7)$$

The direction of this curve at any point is obtained by finding the value of $\frac{dy}{dx}$ at that point. From (4) and (5) is obtained

$$\frac{dx}{da} = [R + r \cos na] \cos - rn \sin a \sin na \quad - \quad . \quad (8)$$

$$\frac{dy}{da} = - [R + r \cos na] \sin a - rn \cos a \sin na \quad - \quad - \quad (9)$$

Divide (9) by (8) and obtain

$$\frac{dy}{dx} = - \frac{[R + r \cos na] \sin a + rn \cos a \sin na}{[R + r \cos na] \cos a - rn \sin a \sin na} \quad - \quad (10)$$

If in (10) $na = m \frac{\pi}{2}$ where m is an *even integer*, then $\sin na = 0$, and

$$\frac{dy}{dx} = - \tan a \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad (11)$$

If $na = m\frac{\pi}{2}$ and m is an *odd integer*, then $\sin na = \pm 1$, and $\cos na = 0$, then

$$\frac{dy}{dx} = -\frac{R \sin a \pm rn \cos a}{R \cos a \mp rn \sin a} = -\frac{R \tan a \pm rn}{R \mp rn \tan a} \quad . \qquad (12)$$

Equation (11) gives the direction of the curve at such points as a or b, Fig. II., and shows that it is here perpendicular to the radius, drawn to the points, of the projection of the circular axis of the torus.

Equation (12) gives direction of the curve at such points as c or d.

Let dS be the tangent to the curve at d; the tangent of the angle β that dS makes with Ox is given by (12).

Draw od, and dm perpendicular to od. dm is tangent to the projection of the circular axis of the torus.

$\angle doy = a = dmo$.

$\angle ldm = \beta + a$ is the angle that the curve at d makes with the projection of the circular axis of the torus.

$\angle ldm = \varphi$.

$$\tan \varphi = \frac{\tan \beta + \tan a}{1 - \tan \beta \tan a} \text{; but from (12)}$$

$$\tan \beta = -\frac{R \tan a \pm rn}{R \mp rn \tan a}. \text{ Therefore,}$$

$$\tan \varphi = \frac{-\dfrac{R \tan a \pm rn}{R \mp rn \tan a} + \tan a}{1 + \dfrac{R \tan^2 a \pm rn \tan a}{R \mp rn \tan a}}$$

$$= \frac{-R \tan a \pm rn + R \tan a \pm rn \tan^2 a}{R \mp rn \tan a + R \tan^2 a \pm rn \tan a}$$

$$= \frac{\pm rn (\tan^2 a + 1)}{R (\tan^2 a + 1)} = \pm \frac{rn}{R}$$

This means that the curve always crosses the circle cdK at a constant angle.

From page 2 $n = \frac{a'}{a}$, which gives $\tan \varphi = \pm \frac{ra'}{Ra} = \frac{V'}{V}$,

where V' is the velocity of generating point in space, due to its rotation about its axis, and V is its velocity, at the same instant, due to its rotation about the axis of the generating curve.

na is always equal to θ. Let n' be the number of turns the spiral makes about the torus while a increases from 0 to 2π. When $a = 2\pi$, $\theta = 2\pi n'$; but $n = \frac{\theta}{a} = \frac{2\pi n'}{2\pi} = n'$.

The helix is a special case of a spiral on a torus, where the radius of the circular axis is equal to infinity. To obtain the equation of the helix, transfer the origin of coördinates from o to o' in Fig. II. Equations (4), (5) and (6) become

$$x = [R + r \cos na] \sin a \qquad (13)$$
$$y = [R + r \cos na] \cos a - R \qquad (14)$$
$$z = r \sin na \qquad (15)$$

Now if in these equations R is made infinite, n will equal infinity and a will equal zero; but $na = \theta$ always, and Ra S, $\sin a = a$.

Making these changes in (13), (14), and (15), the equation of the helix is obtained as

$$x = R \sin a = Ra = S \qquad (16)$$
$$y = r \cos \theta \qquad (17)$$
$$z = r \sin \theta \qquad (18)$$

S in (16) means simply the distance out from Oy, that the point has moved; and, as $S = R\,a = Rat = Vt$, where $a =$ angular velocity of the plane, and V the linear velocity of the generating point, which in this case is constant, it is seen that the helix is not formed by a combination of two rotations, but by a rotation and translation, as it should be.

In the general equation (1), (2), and (3), let, now, $f(xya) = R$, a constant, and $f(yzna) = r' - cRa = r$.

This would give us the equations of a spiral on a horn-shaped surface.

When $f(yzna) = 0$, then $a = a'$, and $r' = cRa'$, or $c = \frac{r'}{R'a}$. Therefore, $f(yzn) = ar'\left(1 - \frac{Ra}{Ra'}\right)$.

If $a = 0$, $f(yzn\,\alpha) = r'$, or r' is the initial value of $f(yzn\,a)$. These values in the general equations give

$$x = [R + r'(1 - \frac{Ra}{Ra'}) \cos na] \sin a \quad - \quad - \quad - \quad (19)$$

$$y = [R + r'(1 - \frac{Ra}{Ra'}) \cos na] \cos a \quad - \quad - \quad - \quad (20)$$

$$z = r'\left(1 - \frac{Ra}{Ra'}\right) \sin na \quad - \quad - \quad - \quad - \quad - \quad (21)$$

Transferring the origin, as was done in the case of the helix, and making $R = \infty$.

$$x = Ra = S \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad (22)$$

$$y = r'\left(1 - \frac{S}{S'}\right) \cos \theta = \frac{r'}{S'}(S' - x) \cos \theta \quad - \quad - \quad (23)$$

$$z = r'\left(1 - \frac{S}{S'}\right) \sin \theta = \frac{r'}{S'}(S' - x) \sin \theta \quad - \quad - \quad (24)$$

These are the equations of a spiral on a cone.

These examples will suffice to show how simple is this method of generating curves in space. The generating curve, or the curve traced by the axis of the point, or both, may be an hyperbola, an ellipse, a parabola, an Archimedean spiral, or, in fact, any curve whose equation is known.

A Revision of North American Linaceæ.

By William Trelease.

At the suggestion of Dr. Gray, to whom, as well as to Mr. Watson, I am indebted for many courtesies, I have carefully gone over our species of *Linum*, with a view to revising them for the Synoptical Flora, and the following arrangement of species, which is believed to be a nearly natural one, is offered to call attention to doubtful and rare species, as well as to facilitate the study of the group, until the publication of the next volume of the Flora. I shall be grateful for any aid that may be afforded by correspondents, in the communication of further specimens or of critical notes.*

No comprehensive study of our species of *Linum* has been made since the publication of vol. i. of Torrey & Gray's Flora of North America, in 1838–40, and of a classical monograph of the entire Order by Planchon, in 1847–48.† Dr. Engelmann contributed a revision of the difficult group *Linopsis* to Gray's Plantæ Wrightianæ, in 1852.‡ The Pacific Coast section *Hesperolinon*, established by Dr. Gray, in 1865,§ and subsequently reviewed by him,‖ was monographed by Brewer & Watson, 1876–80.¶ An enumeration of all our species known in 1878, with full synonymy and bibliographical references, is to be found in Watson's Bibliographical Index to North American Botany, i. 146, 458.

* My thanks are especially due to Dr. N. L. Britton for the use of specimens belonging to the herbaria of Columbia College, and to Professors A. N. Prentiss and W. R. Dudley for those in the herbarium of Cornell University, during the preparation of this paper, which, however, is based mainly on the specimens of the Gray herbarium of Harvard College.

† Hooker's Journal of Botany, vi.–vii.

‡ Smithsonian Contributions, iii., pt. 1, p. 25; reprinted in Collected Botanical Writings, p. 516.

§ Proc. Amer. Acad. Arts & Sci., vi. 521.

‖ L. c. vii. 333.

¶ Botany of California, i. 89; ii. 438.

Our representatives of the Order *Linaceæ* belong to the tribe *Eulineæ* of Planchon and Bentham & Hooker, so that for our purpose, aside from all consideration of the doubtful propriety of including *Erythroxyleæ*, &c., in the Order, the ordinal characters may be limited to those which characterize this tribe, which includes, in addition to *Linum*, only the small genera *Radiola*, of a single species, characterized by its 4-merous flowers, and *Reinwardtia*, with a few shrubby species which resemble our Hesperolinons in having 5-merous flowers, rendered unsymmetrical by a reduction in the number of carpels, and (?) appendaged petals.*

In a study of *Hesperolinon* considerable assistance is apparently to be obtained from the appendages of the petals (Pl. IV.), which represent delicate, more or less crenate or lacerate scales across the inner or ventral face of the claw, and correspond in position to a hairy line well developed on the unappendaged petals of *L. Berlandieri* and related species of *Linastrum* (Pl. IV. fig. 12). I shall be glad to learn from those who have the opportunity to observe these Californian plants in the field, how constant the appendages prove to be.

The form and dehiscence of the capsule offer some of the most evident characters in studying the genus as a whole, and, so far as I have been able to learn, these are quite constant. Dr. Engelmann has indicated that the capsules of the *rigidum* group are provided with a series of curious dark brown cartilaginous insertions (Pl. III. fig. 7-11), which are situated at the base of the partitions between the carpels (not opposite the false septa, as he states, apparently by a slip of the pen). While the capsule usually splits into twice as many valves or cocci as there are carpels, in these species, as Engelmann has shown, the number of valves is equal to that of the carpels, but each consists of the halves of two carpels, the primary dehiscence of the capsule occurring through the false septa.

An interesting biological consideration in a comprehensive study of Linaceæ is that relating to the homogony or heterogony of their flowers; but, as the New World species are exclusively

* On *Reinwardtia* see Urban: Verhandl. Bot. Verein. Prov. Brandenburg, 1881, xxii. 18-23; Abstracts in Just's Bot. Jahresb. vii. (1), 130; viii. (2), 123.

homogone,* and clearly endemic with one exception (excluding, naturally, the somewhat abundant escapes of cultivated flax), this concerns us only indirectly. The exception referred to is the common blue-flowered flax of the western mountains and plains, called *L. Lewisii* by Pursh, and of late years united with *L. perenne* of the Old World.

The European representatives of this species, though variable, are generally referred to a single species, but often with varietal names; and our plants, although they vary much in appearance, cannot be regarded as representing more than one species, nor do they differ essentially from European forms of *L. perenne* except in one particular. According to Darwin† and Hildebrand‡ the Old World *L. perenne* is heterogone-dimorphic and self-sterile. The American plant, on the other hand, does not appear to be heterogone. Most specimens correspond to the long-styled form of a dimorphic species, but flowers sometimes occur with the styles no longer than the stamens, and I have seen one plant with styles scarcely reaching the base of the anthers. According to Meehan§ the American plant is self-fertile.

It appears, therefore, that forms of a single species, originally distributed over the northern portion of both continents (not in eastern America, however), have in the course of time differentiated so far as to acquire heterogony in the Old World, or lose it in the New—the latter appearing more probable.

Some references concerning the pollination of *Linum* and the structure and dissemination of its seeds will be found below.||

* On this subject see Urban: Linnæa, xli. 609; Abstract in Just's Bot. Jahresbericht, v. 442, 739.

† Different Forms of Flowers, various places. (See also the original paper in Journ. Linn. Soc., Bot. vii. 75, and abstract in Amer. Journ. Sci., 2 ser. xxxvi. 279-284.)

‡ Halle Zeitschr. ges. Wiss. xxiii. 51:.

§ Bull. Torrey Bot. Club, vi. 189. See also Gray: Amer. Journ. Sci., 3 ser. xv. 222.

|| The principal literature pertaining to the pollination of Linaceæ is indicated in the following list:

Alefeld: Bot. Zeitung, 1863, xxi. 281 (indication of dimorphism in many species). Darwin: Journ. Linn. Soc., Bot. 1863, vii. 69; Amer. Journ. Sci. and Arts, 1863, 2 ser. xxxvi. 279; Different Forms of Flowers in Plants of the same Species, various places (dimorphism and mode of pollination of *Reinwardtia*, p. 100, and several species of *Linum*). Delpino: Ulteriori Osservazioni, ii. (2) 94 (nectariferous staminodia). Fritsch: Beobachtungen uber Pflanzen deren Blumen sich täglich öffnen u. schliessen (time of opening and closing of flowers of *L. usitatissimum*). Gray: Amer. Journ. Sci. and Arts, 1878, 3 ser. xv. 222 (*L. Lewisii*). Henslow: Trans. Linn. Soc., Bot. 1877, n.s. 1. 357 (*L. catharticum*); Pop. Sci. Rev. 1879, xviii. Hildebrand: Halle Zeitschr. ges. Wissensch. 1864, xxiii. 417, 511; Bot. Zeit. 1864, xxii. 1 (*L. perenne*). Koch: Synopsis Flor. Germ. et Helv. (noted

LINACEÆ.

Annual or perennial caulescent herbs or low shrubs. Leaves alternate, sometimes opposite or subverticillate below; simple, generally entire, sessile or nearly so, mostly estipulate. Inflorescence usually cymose. Flowers hermaphrodite, 4–5-merous, hypogynous. Sepals valvate. Petals convolute, distinct or nearly so. Stamens as many as the petals and alternate with them, monadelphous at the base, sometimes with intermediate processes, persistent; anthers oblong, introrse, more or less versatile, 2-celled, dehiscing longitudinally. Styles 2–5. Ovary slightly 4–10-lobed, its cells equal in number to the styles, or twice as many, from the intrusion of a false partition from the back of each cell; the true cells 2-ovuled. Seeds oily, with a little albumen; embryo usually straight, with plane cotyledons. Glands of the receptacle 5, mostly small, opposite the sepals.—About 90 species, widely distributed.

Linum, L., Gen. No. 389. Benth. & Hook. Gen. Plant. i. 242.—Leaves estipulate, or with a pair of rounded glands occupying the place of stipules. Flowers 5-merous, symmetrical except that the carpels are fewer than the other parts in one section. Sepals persistent and at length deciduous. Petals fugacious. Capsule splitting through the false septa, and also septicidal in most species.—About 80 species, chiefly in temperate regions.

SYNOPSIS OF NORTH AMERICAN SPECIES.

* Flowers large, blue; sepals not glandular-margined; carpels 5, not cartilaginous at base; styles distinct.

Annual; stigmas elongated; false septa incomplete.

Capsule rather short, not dehiscent, septa not ciliate .... *L. usitatissimum*.

Capsule longer, dehiscent; septa ciliate within .... *L. humile*.

Perennial; stigmas not much longer than broad; capsule incompletely 10-celled, widely dehiscent .... *L. Lewisii*.

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heterogony of several species). Meehan: Bull. Torrey Bot. Club, 1877, vi. 189 (*L. Lewisii*). Müller: Befruchtung der Blumen, 167; Weitere Beobachtungen, 219 (visitors of *L. usitatissimum*). Planchon: Hooker's Journ. Bot. 1848, vii. 174, 175 (flowers of *L. salsoides* and *L. Lewisii*). Thomson: Trans. Bot. Soc. Edinburgh, xiv. 102 (*L. monogynum*). Treviranus: Bot. Zeit. 1863, xxi. 189 (note on heterostylism). Urban: Linnæa, neue Folge, vii. 609 (South American species homogone); Verhandl. Bot. Ver. Brandenburg, 1881, xxii. 18 (on *Reinwardtia*).

On the structure of the seed-coats of *Linum* see, among others: Gärtner: De Fruct. et Semin. Plant ii. 146, pl. 112, f. 11. Harz: Landwirtsch. Samenkunde, 950, f. 80. Hildebrand: Bot. Zeit. 1872, 909. Hofmeister: Kön. Sächs. Ges. Naturwiss. 1858, 20, pl. 1. f. 1. Nägeli and Kramer: Pflanzenphysiol. Unters. 1–3, pl. 27, 28. Nobbe: Handb. Samenkunde, 77, 78, f. 81. Sempelowski: Beitr. z. Kenntniss des Baues der Samenschale. Thesis, Leipzig, 1874, 3. pl. 1, f. 1–3.

The germination of the fatty seeds of flax is discussed by Jorissen: Bull. Acad. Roy. Belg. 1884, vii.

* * Flowers medium-sized or small, yellow; sepals more or less glandular-ciliate or serrulate; carpels 5.
  - Calyx persistent; capsule about 3 mm. long, 10-valved; carpels without cartilaginous insertions at base.
    - Leaves and bracts entire; without stipular glands.
      - False septa essentially complete, not ciliate.
        - Stem terete below; only the lowest leaves opposite; growing in dry places.
          - Capsule ovoid, about 3 mm. long .... *L. Floridanum*.
          - Capsule depressed-globose, about 2 mm. long .... *L. Virginianum*.
        - Stem low-angled: leaves mostly opposite below the first branch; growing in wet places .... *L. striatum*.
      - False septa incomplete, ciliate.
        - Annual or biennial, inflorescence virgate.......... *L. Neo-Mexicanum*.
        - Perennial, shrubby; flowers corymbose-paniculate .... *L. Kingii*.
    - Upper leaves and bracts glandular-ciliate or serrulate; stipular glands usually present; stems angled.
      - Annual, leaves 3-keeled, glabrous .... *L. sulcatum*.
      - Perennial, leaves 1-nerved, somewhat puberulent-roughened .... *L. rupestre*.
  - Calyx at length deciduous (except in the last); capsule 4–5 mm. long, 5-valved through the false septa; carpels with triangular cartilaginous insertions at base; false septa complete.
    - Leaves rather remote on the branches, never imbricated; stipular glands commonly present; false septa more or less thickened outwardly.
      - Glaucous, often puberulent-roughened; leaves narrow and rather rigid.
        - Branches slender; sepals rather narrow, mostly twice as long as the capsule, broadly scarious and very slender-pointed; false septa thickened for a very small distance at the back.......... *L. aristatum*.
        - Stouter; sepals broader, about half as long again as the capsule; false septa thickened for about one-third their width.......... *L. rigidum*.
      - Green; leaves often broader and less rigid; false septa thickened for half of their width .... *L. Berlandieri*.
    - Leaves crowded and overlapping on the slender branches; sepals persistent; false septa entirely membranaceous .... *L. multicaule*.

* * * Flowers mostly small, yellow, white, or rose-purple; sepals often glandular-ciliate; petals mostly appendaged at base; carpels 2–3; styles distinct.
  - Carpels 2; false septa complete; petals not appendaged .... *L. digynum*.
  - Carpels 3; false septa incomplete; petals often 2-toothed below, usually with a median and a pair of more or less developed lateral ventral appendages at base.
    - Leaves all glandular-denticulate; false septa very narrow.
      - Leaves broadly oval, pointed: flowers rose-colored .... *L. drymarioides*.
      - Leaves linear, obtuse; flowers yellow .... *L. adenophyllum*.
    - Leaves entire, without marginal glands; false septa wide below.
      - Flowers yellow.
        - Stems sparingly forked; pedicels short; appendages of petals somewhat hairy .... *L. Breweri*.
        - Repeatedly dichotomous; pedicels rather long and slender; appendages of petals glabrous.......... *L. Clevelandi*.
      - Flowers very small, white; pedicels slender .... *L. micranthum*.
      - Flowers rose-colored or purplish:
        - Nodding on long slender pedicels, remote .... *L. spergulinum*.
        - Erect, short-pedicelled, mostly densely clustered at ends of the branches.
          - Sepals glandular-ciliate, otherwise glabrous.......... *L. Californicum*.
          - Sepals pubescent, not glandular .... *L. congestum*.

* Estipulate; pedicels elongated; flowers large, blue; sepals not glandular-margined, persistent; filaments with slender intervening appendages; carpels 5, not cartilaginous at base; styles distinct; capsule with membranous septa, the half-carpels somewhat longitudinally concave and 2-grooved on the back; seeds compressed. —§ *Eulinum*.

L. USITATISSIMUM, L. Spec. 277.— Annual, glabrous and glaucous, a foot and a half high; stem simple or mostly cespitose, longitudinally striate; leaves not crowded, lanceolate, very acute, 3-nerved (2–5 × 15–35 mm.); flowering branches corymbosely clustered above, loosely leafy; sepals broadly oval, short-acuminate, the interior scarious-margined and ciliate, 3-keeled, the lateral nerves shortly evanescent; petals obcuneate, rounded and crenulate at apex, about 10 mm. long, twice the length of the calyx; stamens one-half longer than the sepals, appendages minute; pistil equal to the stamens; stigmas elongated, subclavate, about as long as the styles; capsule broadly conic-ovoid, about 7 mm. long, and equal to the calyx, subindehiscent, incompletely 10-celled, the septa not ciliate; seeds 4–6 mm. long.—Along railroads, &c., escaped from cultivation.

L. HUMILE, Mill. Dict. No. 2; Planch. *l. c.* vii. 166. *L. usitatissimum*, var. *crepitans*, Schub. & Mart. — Resembling the last, but the capsule longer (8 mm.), dehiscent, with ciliate septa.— Escaped in similar situations to the last.

It is an open question whether these cultivated flaxes, which do not properly belong to our flora, are to be regarded as constituting two distinct species, or only well-marked hereditary races of a single species. Planchon, whose opinion on the genus is worthy of careful consideration, held them to be distinct, and has been followed by Boissier and other weighty authority; while DeCandolle, with a bias in the other direction, takes the other view, uniting with them the perennial *L. angustifolium*, which I have not seen from America. It is interesting to note that the old Egyptians cultivated *angustifolium* and *humile*, while the Swiss Lake-dwellers had the former species. *L. humile* is said to be even yet the only form cultivated in Abyssinia, but *usitatissimum* is now grown in Egypt, as elsewhere.*

1. L. LEWISII, Pursh. Fl. Am. Sept. i. 210. *L. perenne*, var. *Lewisii*, Eat. & Wr.; Planch. *L. Sibiricum*, var. *Lewisii*, Lindl. *L. decurrens*, Kellogg. *L. Lyallanum*, Alefeld. *L. perenne* of the later treatises on American botany.—Mostly perennial, glabrous and glaucous, a couple of feet high; stems mostly cespitosely clustered, striate; leaves often somewhat crowded, oval-linear, acute or subobtuse; 3–5-nerved (.5–5 × 5–35 mm.); flowers rather corymbose; sepals broadly oval, mostly pointless,

* See a posthumous paper by Alexander Braun in Zeitschr. f. Ethnologie, Berlin, ix. 289 (Just's Bot. Jahresbericht, vi.[2] 474); and DeCandolle: Origine des Plantes Cultivées, 95–103. At p. 96 of the latter work will be found a succinct tabulation of the distinctive features of these forms, based upon the investigations of Heer.

the inner scarious-margined, sometimes erose but not ciliate, more or less 3–5-keeled below; petals 15–20 mm. long, thrice the length of the calyx; stamens equal to or twice as long as the sepals, appendages slender; pistil once to twice the length of the stamens; stigmas short, not more than twice as long as broad; capsule 2 or 3 times as long as the calyx, ovoid, obtuse, incompletely 10-celled and 10-valved, the valves dehiscing widely above and separating through the partitions nearly to the center below, the septa ciliate.—Alaska to Saskatchewan and the Great Plains, south to Arkansas and Texas.

The aspect of this species is subject to much variation, the shorter, more cespitose plants usually having more crowded and narrower leaves than the taller forms. If the Siberian form of *L. perenne* agrees with the European in having heterogone flowers, our plant must stand as distinct, otherwise it may bear Eaton and Wright's name. The Asiatic material at my command is too limited to decide this point.

* * Estipulate or with stipular glands; pedicels usually short; flowers small or medium sized, yellow; sepals more or less glandular-ciliate or serrulate, persistent or deciduous; filaments without intervening appendages; carpels 5, sometimes with cartilaginous insertions at base; styles distinct or united; stigmas capitate; capsule with firm septa, the false septa sometimes membranous toward the inner margin or incomplete and ciliate.—§ *Linastrum*.

2. L. FLORIDANUM. *L. Virginianum*, var. ? *Floridanum*, Planch. *l. c.* vii. 480. *L. Virginianum*, in part, of Chapman.—Perennial, glabrous, 1½–2 feet high; stems several from the same root, erect, simple below, terete and striate or the branches slightly angled; leaves remote or somewhat approximated, the lowest pair or two usually opposite, oblong or oblong-lanceolate, mostly acute, 1-nerved (1–5 × 10–20 mm.), without stipular glands; flowering branches mostly few, ascending or recurving, with rather few sometimes secund flowers, not very leafy; sepals ovate, taper-pointed, keeled, the inner edges glanduliferous; petals spatulate-obovate, 5–6 mm. long, about twice the length of the calyx; stamens and pistil about equal to the calyx, intervening appendages reduced to mere thickenings of the membrane; capsule ovoid, about 3 mm. long, equaling or exceeding the calyx, essentially 10-celled, with firm septa.—Florida to Louisiana. Well represented in Curtiss's North American Plants, No. 412, from the dry pine barrens of Duval Co., Florida. I also refer here a large-fruited plant labeled from Illinois, in Hb. Gray, without date or name of collector.

3. L. VIRGINIANUM, L. Spec. 279.—Similar to the last, but more loosely branched, the flowering branches recurved-spreading or corymbose; capsule depressed-globose, very obtuse, about 2 mm. long.—Dr ysoil from Canada to Texas. A variable plant, of which Planchon recognizes several varieties.

4. L. STRIATUM, Walt. Fl. Carolin. 117. *L. Virginianum*, Reich. *L. Virginianum*, var. *oppositifolium*, Engelm. *L. rigidum*, Torr. & Gr., in part. *L. Virginianum*, var. ? *diffusum* and *L. diffusum*, Wood. — A foot or two high; stems simple or subcespitose, ascending, striate and somewhat wing-angled even below; leaves opposite below the first branch, elliptical-oblong, acute, 1-nerved; flowering branches mostly short and spreading, at length racemose along the stem; capsule subglobose; otherwise like the last. — Bogs and wet places, Canada to the Gulf, and west to Arkansas.

The leaves are of a yellower green than in the last, and, as indicated by Austin, the plant is slightly viscid, so as to adhere a little to the paper when in press. Specimens that clearly belong here were collected in dry soil in Canada by Macoun, but the species is usually found in wet places.

5. L. NEO-MEXICANUM, Greene, Bot. Gazette, vi. 183. — Annual or biennial, glabrous, a foot or two high; stems considerably branched below, strict, striate and angled above; leaves alternate except the lowermost, oblong, the lower mostly obtuse and the upper acute, 1-nerved (2 × 8–15 mm.), without stipular glands; flowers often on rather long erect pedicels (at length 5–10 mm.) forming long virgate racemes; sepals lanceolate, obtuse, acute or abruptly taper-pointed, keeled, the inner with minutely glandular margins; petals oblong-spatulate, about 5 mm. long, one-half exceeding the calyx; stamens and pistil equal to the petals; styles distinct; capsule ovoid-acute, somewhat constricted below the top, 3–4 mm. long, a little longer than the calyx, the false septa incomplete above and ciliate. — Pine woods in the mountains of New Mexico (*Greene*, *Matthews*) and Arizona (*Lemmon*, *Jones*).

6. L. KINGII, Watson, Bot. Fortieth Parallel, 49.—Perennial, fruticose, glabrous and usually very glaucous, a span to a foot high; stems rather thick, cespitose, the striate or somewhat angled branches ascending; leaves rather thick, crowded and somewhat appressed, oblong or spatulate, subacute, 1-nerved, (2 × 8–10 mm.), larger, more remote and spreading above, without stipular glands; flowers rather large, densely corymbose-paniculate at the ends of the branches; sepals small, broadly oval, obtuse or taper-pointed, the inner glandular-ciliate, 3-nerved, with the midnerve rather prominent; petals oblong-obovate, entire or slightly crenate, with contracted glabrous claws, 5–10 mm. long, several times as long as the calyx; stamens and pistil two-thirds as long as the petals; anthers rather large (2 mm. long); styles distinct; capsule ovoid, acute, somewhat longer than the calyx, the false septa incomplete nearly to the base and ciliate. — Mountains of Utah (*Watson*, *Hayden*, *Hooker & Gray*). Old specimens with widely spreading capsules suggest the fruit of *Sedum*.

7. L. SULCATUM, Riddell, Cat. Pl. Ohio, Suppl. 10. *L. striatum*, Nutt. *L. rigidum*, Torr. & Gr. and Wood, in part. *L. Boottii*, Planch.

? *L. simplex*, Wood. — Annual, glabrous, a foot or two high; stem subsimple below, corymbosely branched above, rather prominently wing-angled; leaves alternate, lanceolate, very acute, 3-nerved, the lateral veins marginal: the lower entire, the uppermost smaller and glandular-serrulate (about 2 × 20 mm.); stipules represented by a pair of subglobose glands; flowers mostly corymbed at the ends of the branches; sepals lanceolate, very acute, keeled and with a pair of more or less prominent lateral nerves, conspicuously glandular-serrulate, occasionally elongated and leaf-like in the lower flowers; petals spatulate, entire, slightly bearded at base, about 7 mm. long, one-half longer than the calyx; stamens and pistil about equaling the calyx; styles distinct to or below the middle; capsule ovoid, rather acute, about 3 mm. long, rather shorter than the calyx; false septa incomplete above and ciliate.—Dry soil, Eastern Canada to Saskatchewan, south to Texas. An Arkansas specimen collected by Gattinger is apparently destitute of stipular glands.

8. L. RUPESTRE, Engelm. Pl. Lindheimer. 232. *L. Boottii*, var. *rupestre*, Engelm. — Perennial, with slender cespitose stems a foot or two high, subsimple below, corymbose above, rather prominently angled; leaves more or less opposite at base, alternate above, linear-acute, one-nerved (1–2 × 10–15 mm.), sparingly and minutely hairy on the margins and midrib below, the upper remote, appressed, glandular-serrulate; stipular glands small; sepals ovate, very acute or almost bristle-pointed, keeled and with a pair of fainter lateral nerves, glandular-serrulate; petals spatulate, truncate or emarginate, 5–10 mm. long, mostly quadruple the length of the calyx, bearded at base, bright yellow, or pale when large; stamens and pistil about twice as long as the calyx; styles distinct: capsule globose-ovoid, about equaling the calyx, its false septa incomplete and ciliate except at base. — New Mexico and Texas to Mexico.

9. L. ARISTATUM, Engelm. Wislizenus's Rep. 17. *L. rigidum*, in part, of various collections. — Green or somewhat gray, a span to a foot high, much branched toward the base, the glabrous or puberulent branches slender, ascending, somewhat angled; leaves erect, narrow (1 × 5–8 mm.), tapering to an awn-tipped point, the upper glandular-serrulate; stipular glands small; flowers rather few, subsolitary at the ends of the branches, their pedicels as much as 15 mm. long; sepals lanceolate, very acute and bristle-pointed, rather thin, with a prominent midvein and occasionally two lateral ribs above, their broadly scarious margins glandular-ciliate or mostly lacerate; petals pale and very delicate, cuneate-spatulate, 12–15 mm. long, one-half longer than the calyx, bearded at base; stamens and pistil about as long as the sepals; styles distinct for about 1 mm. at top; capsule ovoid, half or two-thirds as long as the calyx, 10-celled, the false septa membranaceous except for a short distance from the outer margins, slightly ciliate within. — Southern Utah, Arizona and New Mexico. Closely related to *L. rigidum*.

10. L. RIGIDUM. Pursh. Fl. Am. Sept. 210. — Glabrate or slightly puberulent, glaucous, a span to a foot high, mostly low and cespitose, corymbosely branched above, the rigid branches more or less angled; leaves rather remote, erect, narrowly lanceolate or linear (.5–1.5 × 5–20 mm.), mostly mucronate and 1-nerved, the upper glandular-serrulate; stipular glands sometimes wanting; pedicels short or sometimes equaling the large yellow flowers; sepals lanceolate, slender-pointed and more or less awned, strongly 1–3-nerved, conspicuously glandular-serrulate; petals obovate-cuneate, as much as 15 mm. long, and double the length of the calyx, with short slightly bearded claws; stamens equaling or somewhat surpassing the sepals; styles often longer than the stamens, distinct for about 1 mm. at top; capsule ovoid, about one-third shorter than the calyx, the false septa thickened for about one-third their width from the back, slightly ciliate.—Saskatchewan to Texas and Mexico.

A tall, pale-flowered plant collected on the Upper Missouri and in Ellis Co., Kansas, is apparently a form of this species. A specimen from Montana (*Scribner*, 1883, 17, *c.*) is referred here, but it is apparently not glaucous and needs further investigation. I have also seen a single specimen from Miami, Florida (*Garber*), which is referred to the next by Chapman (Supplement, 611).

Var. PUBERULUM, Engelm., in Gray's Pl. Wright. i. 25, is a low, prominently gray-puberulent form, with mostly smaller flowers, occurring from Colorado to New Mexico, and west to California.

11. L. BERLANDIERI, Hook. Bot. Mag. pl. 3480, as *L. Berendieri*. *L. rigidum*, var. ? *Berlandieri*, Torr. & Gr. *L. annuum*, Nees. — Green, a span to a foot high; stem cespitose, more or less corymbosely branched and strongly angled above; leaves broader and more spreading than in related species (1–7 × 5–30 mm.), nearly all entire, pointed, more or less 3-ribbed, with or without stipular glands; bracts smaller, glandular-serrulate; pedicels mostly decidedly shorter than the large yellow flowers; sepals lanceolate, tapering to a very acute awned tip, glandular-serrulate, usually strongly 3-ribbed and often with an additional pair of ribs evanescent below; petals obovate-cuneate, more or less crenulate, hairy at base, 10–20 mm. long, about twice the length of the calyx; capsule large (about 5 mm. long), ovoid, very obtuse below, about one-third shorter than the calyx, the false septa thickened for about one-half their extent. — New Mexico (*Thurber*, 275) and Texas. Specimens collected by Drummond have the margins of the broad sepals often irregularly dentate and the staminal tube ciliate. This form, which is *L. Plotzii*, Hook. *l. c.*, and in various herbaria, may, perhaps, be separated as Var. PLOTZII.

12. L. MULTICAULE, Hook. in Torr. & Gray, Fl. N. Am. ii. 678. *L. selaginoides*, Torr. & Gr., not Lam. *L. hudsonioides*, Planch. — Glaucous, an inch to a span or two high, cespitose, the slender rough-angled stems simple below, cymosely few-branched above; leaves imbricately appressed over the entire stem, minute (.5–1 × 5 mm.), narrowly trian-

gular, bristle-pointed, more or less scarious-margined and remotely denticulate, 1-nerved, the base of the mid-rib callous, without stipular glands: pedicels about equal to the flowers; sepals broadly ovate, somewhat acuminate, bristle-pointed, more or less evidently 1-nerved, with broad scarious subentire or glandular-ciliate margins, persistent: petals pale, obovate-cuneate, (8-10 mm. long,) two or three times as long as the calyx, bearded just above the base: stamens and pistil of equal length, about as long as the sepals; styles distinct only at the apex; capsule globose-ovoid, about as long as the calyx, the false septa entirely membranaceous. —Texas.

* * * Estipulate or with stipular glands; pedicels often elongated; flowers medium sized or mostly small, yellow, white or rose-purple; sepals usually glandular-ciliate, persistent; petals commonly with lateral teeth and 1-3 ventral appendages at base; filaments without intervening appendages, but sometimes 2-toothed at base; carpels 2-3, without cartilaginous insertions; styles distinct; stigmas small, oblique, or subcapitate; capsule with firm septa, long-ciliate at base, the false partitions mostly incomplete; seeds mostly plump; annuals.—§ *Hesperolinon.*

13. L. DIGYNUM, Gray, Proc. Amer. Acad. vii. 334. — About a span high, glabrous; stems slender, several times forked, rather prominently angled above; leaves mostly opposite, elliptical-spatulate, the lower obtuse and entire, the upper acute or mucronate and remotely serrulate, somewhat 3-nerved (2-3 × 7-10 mm.), without stipular glands; flowers at length loosely corymbose or subracemose, small, yellow; pedicels short, about equal to the flowers: sepals ovate-oblong, rather obtuse, somewhat faintly 1-3-nerved or keeled at base, minutely serrulate, glandular and lacerate below, two of them mostly conspicuously longer and very blunt; petals spatulate-oblong, truncate or emarginate, neither toothed nor appendaged, about 3 mm. long, one-half longer than the sepals; stamens and pistil a little shorter than the calyx; carpels 2; capsule a little shorter than the calyx, ovoid, slightly retuse at apex, somewhat rough, completely 4-celled, the walls and septa rather thick; seeds .5-1 mm. In habit resembling a small form of *L. Virginianum.* — Washington (*Suksdorf*), Oregon (*Howell, Mrs. Summers*), and Northern California (*Bolander*, 4900; *Greene, Lemmon*).

14. L. DRYMARIOIDES, Curran, Bull. Calif. Acad. No. i. 152. —A span or two high, sparingly white-villous; stems rather coarse at base, repeatedly dichotomous, with long slender internodes; leaves opposite or subverticillate below, broadly ovate, acute or acuminate, with short crowded marginal glands, rather loose-veined, (4-6 × 5-10 mm.), the upper much reduced; flowers small, rose-colored, scattered along the ultimate branches; pedicels mostly short; sepals lanceolate, acute or submucronate, minutely serrulate, their margins sometimes glanduliferous; petals ovate, emarginate, 2-toothed and 3-appendaged at base, the median appendage rounded and glabrous; stamens and pistil about equal to the calyx; capsule ovoid-acute, about as long as the calyx, 6-valved, the false septa

incomplete, narrow, widening gradually to the base: seeds .75×2 mm., mottled.—Lake County, California (*Mrs. Curran*).

15. L. ADENOPHYLLUM, Gray, Proc. Am. Acad. viii. 624.—A span to a foot high, subvillous or glabrate; stems slender, repeatedly forking, terete; leaves remote, linear-obtuse, somewhat cordate-dilated at base, closely and conspicuously glandular-denticulate (1-2×5-25 mm.), without stipular glands; flowers yellow or pale, small, terminating the ultimate twigs of the cyme; pedicels very slender, rather longer than the flowers; sepals lanceolate-acute, usually minutely glandular-denticulate; petals obovate-spatulate, mostly emarginate, 3-5 mm. long, about twice the length of the calyx, 3-appendiculate and somewhat hairy at base, the median appendage obovate; stamens and pistil about as long as the petals; filaments abruptly dilated and obtusely bidentate at base; capsule ovoid-acute, about as long as the calyx, false septa very narrow, scarcely widened below.—Western California.

16. L. BREWERI, Gray. Proc. Calif. Acad. iii. 102.—A span to a foot high, somewhat puberulent, glaucous; stems considerably forked above, the branches angled; leaves remote, linear, entire, rather blunt (.8×15-20 mm.), with prominent stipular glands; inflorescence loosely dichotomous or sometimes compact; flowers yellow, medium-sized, pedicels not exceeding them; sepals narrow, acute, somewhat keeled, sparingly glandular-ciliate; petals spatulate, emarginate, about 5 mm. long, double the length of the calyx, 2-toothed and 3-appendiculate, the median appendage oblong, with a very few hairs; stamens and pistil about equal to the petals; filaments not toothed; capsule ovoid-acute, about as long as the calyx, the false septa nearly complete below, abruptly narrowed at about the middle.—California: Mt. Diablo Range (*Brewer*, 1181), Lone Mountain, near San Francisco (*Palmer*, 44).

17. L. CLEVELANDI, Greene, Bull. Torrey Bot. Club, ix. 121.—A span to a foot high, glabrate, repeatedly dichotomous; leaves oblong, obtuse or subacute, entire (.5-1×5-10 mm.), without stipular glands; pedicels slender, spreading, as much as 25 mm. long, many times exceeding the minute yellow flowers; sepals narrow, acute, very sparingly glandular-ciliate; petals obovate-oblong, constricted toward the base, more or less emarginate, 1-2 mm. long, scarcely exceeding the calyx, 3-appendiculate, the median appendage oblong, glabrous; stamens and pistil a little shorter than the petals; capsule ovoid-acute, somewhat longer than the calyx, the false septa complete to about the middle, then suddenly narrowed: seed .5×1.5 mm.—Lake County, California (*Greene*, *Mrs. Curran*).

18. L. MICRANTHUM, Gray, Proc. Am. Acad. vii. 333.—A span to a foot high, glaucous, somewhat soft-pubescent, loosely dichotomous, with slender nearly terete branches; leaves spatulate-oblong, obtuse or subacute, entire, 1-nerved, frequently narrowed at base (1-2 × 5-15 mm.), mostly with stipular glands; pedicels slender, longer than the minute white flowers; sepals ovate-lanceolate to oblong, subacute, the inner slightly

glandular-ciliate; petals obovate, scarcely emarginate, 3–5 mm. long, about twice the length of the calyx, not toothed, and without lateral appendages, the median appendage ligulate and loosely hairy; stamens and pistil about equal to the sepals; filaments round-toothed and slightly hairy at base; capsule ovoid-acute, about equal to the calyx, the false septa incomplete, extending half-way to the axis below the middle, narrowed above; seeds .8 × 1.8 mm., mottled.—California and Oregon.

Forma EXAPPENDICULATUM is a form collected in California by Bridges and distributed by the Smithsonian Institution under the number 42, with narrowly spatulate somewhat erose petals, seemingly destitute of basal teeth and appendages, in this respect similar to those of *L. digynum*, from which, however, the plant differs greatly in habit and in being 3-gynous. It is to be observed that the median appendage is present in some flowers of the type, which itself is described as wanting it.

19. L. SPERGULINUM, Gray, Proc. Amer. Acad. vii. 333.—A span to a foot high, glaucous, with more or less abundant minute spreading hairs; stem simple below, loosely dichotomous above, with slender subterete branches; leaves remote, linear, entire, obtuse, little narrowed at base, (.5–1 × 10–20 mm.) with or without stipular glands; pedicels slender, somewhat nodding, as much as 15 mm. long, several times the length of the pretty rose-colored flowers; sepals ovate, subacute or obtuse, glandular-ciliate; petals obovate, 4–8 mm. long, 2–3 times as long as the calyx, 2-toothed and 3-appendiculate, the median appendage ligulate and bearded; stamens and pistil about equal to the petals; filaments round-toothed at base; capsule ovoid-acute, nearly twice as long as the calyx, the false septa incomplete.—California (*Kellogg*, 91; *Harford*, 89; *Bolander*, 6568; *Miss Monks*). Distinguished from the last by its larger nodding rose-colored flowers, and different petals.

20. L. CALIFORNICUM, Benth. Pl. Hartweg. 299.—A span to a foot and a half high, glabrate or sparingly puberulent, glaucous; stem loosely many times forked above, the branches angled; leaves remote, linear, scarcely acute, entire (1 × 10–30 mm.), with prominent stipular glands; pedicels short, erect, not exceeding the rose-colored flowers which are clustered at the ends of the branches; sepals ovate-lanceolate, acute, keeled below, pale-margined, sparingly glandular-ciliate; petals obovate, scarcely emarginate, 4–6 mm. long, twice the length of the calyx, dilated and 3-appendiculate, the median appendage rounded and hairy; stamens and pistil about as long as the petals, filaments not toothed, the tube glandular-thickened between their bases; capsule ovoid-acute, a little shorter than the calyx, the false partitions broad, gradually narrowed upwards.—Western California.

Var. CONFERTUM, Gray in herb., is a low form more densely leafy and with a contracted inflorescence, the median appendage of the petals obovate.—Mare Island, San Francisco Bay (*Lemmon*, *Greene*).

21. L. CONGESTUM, Gray, Proc. Am. Acad. vi. 521.—About a foot high, glaucous; stem striate, simple below, with several nearly erect, somewhat angled branches above; leaves few, linear, acute, somewhat pubescent (1 × 20-30 mm.), with stipular glands; flowers rose-purple, very short-pedicelled, in glomerate clusters terminating the branches; sepals rather broad, acute, conspicuously pubescent, entirely destitute of marginal glands; petals obovate-spatulate, about 7 mm. long, nearly twice the length of the calyx, 2-toothed and 3-appendiculate, the median appendage unusually long, somewhat hairy; stamens and pistil one-third shorter than the petals, the filaments not toothed; capsule short ovoid, nearly as long as the calyx, cartilaginous-striate at base of septa, 6-celled below.—Marin county, California (*Bolander*, 2386).

* * * *L. trisepalum*, Kellogg, Proc. Calif. Acad. iii. 42, f. 10, is *Helianthemum scoparium*, Nutt., according to Gray, Proc. Amer. Acad. vi. 521.

L. San Sabeanum, Buck. Proc. Phil. Acad. 1861, 450, is *Lechea Drummondii*, Torr. & Gray, according to Gray, Proc. Phil. Acad. 1862, 162.

EXPLANATION OF FIGURES.

PLATE III. FRUIT OF LINUM.

1. *Linum Floridanum*. 2. *L. Virginianum*. 3. *L. rupestre*. 4. *L. Kingii*. 5. *L. Neo-Mexicanum*. 6. *L. sulcatum*. 7, 8. *L. aristatum*. 9. *L. rigidum*. 10. *L. Berlandieri*. 11. *L. multicaule*. 12. *L. digynum*. 13. *L. drymarioides*. 14. *L. Clevelandi*. 15. *L. adenophyllum*. 16. *L. micranthum*. 17. *L. Breweri*. All × 4. — 18. Seed of *L. drymarioides*, × 14.

PLATE IV. PETALS AND FILAMENTS OF § HESPEROLINON.

1. *Linum digynum*. 2. *L. drymarioides*. 3. *L. adenophyllum*. 4. *L. Breweri*. 5. *L. Clevelandi*. 6. *L. micranthum*; A, Forma *exappendiculatum*. 7. *L. spergulinum*. 8. *L. Californicum*. 9. Staminal tube of same, laid open, showing the glands. 10. *L. congestum*. 11. Filaments of same. 12. *L. Berlandieri*, showing the transverse hairy line common to some species of *Linastrum*, and corresponding in position to the appendages of *Hesperolinon*.—All seen from the ventral side, × 14.

ERRATUM.

Page 10, line 18. Sepals persistent *or* at length deciduous.

*The Secondary Base in Geodetic Surveys.**

By O. B. Wheeler.

In geodetic surveys three systems or grades of triangulation are recognized, each having its distinctive base.

The primary system has bases from four to six miles in length, which are measured with the greatest accuracy attainable.

Usually, these bases are from 200 to 400 miles apart, and are connected with lines of triangulation as long as possible compatible with well-conditioned triangles.

The bases of the secondary system, which we wish to consider, are from 1½ to 2 miles in length, usually from 80 to 100 miles apart, and the lines of triangulation are from 2 to 15 miles in length.

The tertiary system has bases from from 1,000 to 2,000 feet in length, usually 10 to 15 miles apart.

In quality, the primary base is too expensive both in the cost of apparatus and in the time required to make a measurement; and the tertiary base, which is a simple chain or steel tape measurement upon the ground, is not sufficiently refined or accurate for the secondary base.

Not long since, the most approved method of measuring a secondary base was with wooden or glass rods on a rope made taut over posts, the rods being grooved to half the size of the rope and clamped by hand to the rope, while a rear rod was carried to the front. The base was measured in sections. There was an imperfect contact in rods, and one can imagine a very uncertain amount of creeping and crawling of the rope base line under unconscious strain on the rope, given by the operators, and under changes of sunshine and shadow, humidity of atmosphere, &c.

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* Read June 6th, 1887.

The secondary base apparatus, latest in use in this country, and therefore presumably the best, is of two forms, each based on primary apparatus. The one—that of the Lake Survey of 1871, described in Report for 1872—is a very approximate copy of the Bache-Würdeman apparatus; the other—that of the Coast and Geodetic Survey, described in Appendix 17, Report for 1880—has the principle of the Repsold apparatus in determining the temperature through the unequal rate of expansion in zinc and steel. Each has end-contact apparatus and are arranged for use on tripods. There is a very uncertain amount of error through backward pressure depending on the stability of the tripods. Even in the delicate primary Bache-Würdeman apparatus on the Keweenaw base, this formerly insignificant source of error was corrected by applying a correction of 0.66 of an inch.*

With the Lake Survey secondary apparatus the measurements were preferably made on a railroad track, the tubes resting on the rail and supported in position by hand, and, when thus made, the measurement must be transferred to stations alongside. The passing trains disturbed the accuracy of such measurement. Formerly if a degree of accuracy of 1 in 200,000 was obtained, the work was considered excellent.

Under the Mississippi River Commission the Assistant Engineer had made use of the Lake Survey apparatus, and also of a 300-foot steel tape. They had introduced many refinements in the use of the tape, such as the suspending of it on wire hooks, to allay friction and for better alignment, and in giving a known tension by means of a known weight.

They had also determined the co-efficients of expansion and elasticity for this tape. But the results for measurements were uniformly rejected in favor of measurements by the secondary base apparatus. The assistants, however, had great confidence in the tape measurements could they be made by night or on an overcast day.

Accordingly on the Missouri River Triangulation, at the outset, it was decided to use the steel tape exclusively, and make the measurements by night.

* See § 27, chap. iii., of No. 24, Professional Papers, Corps of Engineers U. S. A.

The standard 300-foot steel tape and tape thermometer of the Mississippi River Commission were transferred to the Missouri River Commission, and the following improvements have obtained in their use:

(1.) Such preparations are made beforehand that a single measurement of the base is made in the quickest time possible and with the least change of temperature, that single measurements at different mean temperatures may be compared.

(2.) The device of an apparatus called an adjuster, by which at the moment the tape is recorded the tape is suspended at rest in equilibrium under a known tension; this adjuster being in parts, and being readily taken up, carried forward, and placed again.

(3.) The mark of measurement is made on a zinc strip, and transferable to the office for a permanent record of the discrepancies in measurements.

(4.) The length of the tape is determined by measuring a known base of primary triangulation, using the same adjuster and method as is used on the secondary base.

For a two-mile base about 500 stakes from 2 to 3 feet in length, with a cross-section of 4 square inches, are required, and the time for getting them out and setting them is about two days for a party of ten men. A few men, with a transit and tape, set the marking-stakes, place the zinc strips on them in line with the direction of the base, and distribute the other stakes, a supporting stake being at every even 30 feet of the tape. Others, with a guide-frame, set the three platform-stakes about 2½ feet in front of the marking-stakes, and the straining-stake for the rear end of tape about 2½ feet back of the marking-stake. All are driven to the required distance below the top of the marking-stake as shown by the guide-frame, that the tape in use may rest on the zinc strip without pressure. Others set the supporting-stakes just off the line and drive the nails for the friction-hooks. The heads of these nails are in line with points 2 inches above the marking-stakes for any one space between marking-stakes; or, when the 2-inch double-ended hooks are hung upon the nails, the lower ends of the hooks are in line with the center of the top of the marking-stakes.

Inasmuch as rapid work is desirable the tactics of a measurement are important.

"For a 300-foot tape a party of sixteen persons is required, distributed as follows: Observer and assistant at rear end; observer, assistant, and attendant, at front end; nine (9) helpers, one at each supporting-stake—two of these helpers must be able to read thermometers closely and reliably; one recorder; one chief of party as superintendent.

"The rear observer, as soon as he sees or feels the weight applied, adjusts his end approximately and calls out '*ready*.' The front observer replies '*ready*.' The rear observer calls out '*mark*.' The front observer replies '*marked*.'

"The thermometer-readings are then called out and recorded, time and weather noted, and all stand ready to march except the front observer. He makes and numbers a line on the zinc from the puncture made with the engraver's pencil at right angles to the base. This done, he takes the front end of the tape and gives the word '*march*.' All move rapidly forward carrying the tape. Each helper carries the tape in its hook, ready to suspend from the nail-head in the proper supporting-stake. The thermometers are carried attached to a stiff wire-stake, and when read their bulbs are at the elevation of the tape. The superintendent watches against twist in tape and other irregularities. Second and third measurements are so numbered on the zincs. Differences are read to the nearest hundredth of an inch, and the elevation of the marking-stakes taken before the zincs are taken up. The zincs are numbered and saved for future reference.

"In daylight a tape-length can be measured in less than two minutes, or a two-mile base can be measured in an hour. By lamplight one-third more time is required. Three measurements are made in an afternoon and night, the one by daylight being for the practice of the untrained men."

The best measurements are made at night after an overcast day.

The reliability of the measurements is best shown by the results obtained. These are for the four secondary bases measured as follows, corrected for expansion of tape to 62° Fahr.:

Benton Base (*Mon.*)			Ft.	1885. Mean Temp.
1st measurement,	by day	=	9870.304	(86°.5)
2d "	by twilight after a heated day	=	.443	(65°.2)
3d "	by lamplight	=	.388	(58°.9)

From the three, probable error	=	1 in 194,000
" two latter, " "	=	1 in 533,000

Trovers Pt. Base (*Mon.*) 1885.

		Ft.	Mean Temp.
1st measurement, on cool, smoky day	=	9711.916	(61°.3)
2d " by twilight	=	.915	(62°.8)
3d " by lamplight	=	.892	(51.°2)
From all, probable error	=	1 in 1,920,000	
" two latter, " "	=	1 in 1,250,000	

Glasgow Base (*Mo.*) 1885.

		Ft.	Mean Temp.
1st measurement, by day, *sun in last part*	=	7923.237	(45°.6)
2d " by day, *sun in first part*	=	.403	(52°.1)
Probable error	=	1 in 140,000	

But taken in parts (as noted at time of measurement), we have

		Ft.	Mean Temp.
1st 15 tapes of 1st measurement, *overcast sky*	=	4485.635	(42°.1)
and 11 " " 2d " " "	=	3437.709	(49°.3)
Total Base	=	7923.344	

which agrees closely with the mean of the above, and is a very reliable value for the base.

Beverly Base (*Mo.*) 1885.

		Ft.	Mean Temp
1st measurement, by day (hazy sky)	=	7933.803	(79°.5)
2d " by lamplight	=	.797	(65°.5)
3d " by lamplight	=	.821	(58°.8)
Probable error	=	1 in 1,600,000	

The two measurements of the known half of the Olney Base (primary 1879) gave results agreeing within .04 of an inch, or practically identical results. It is 1 in 3,250,000.

But it is possible to determine the probable error in measurement, and also that for the standard tape from the discrepancies on the zinc strips. In the following table, 2d column gives the direct differences in inches as read from each zinc strip; 3d column, discrepancies due to expansion and errors of observation, and 6th column gives the same corrected for expansion. The expansion for 1° Fahr. in one tape-length is 0.025 inch. The probable error in measurement for a distance of 36 tapes (= 10,767 feet) is $\pm$0.0719 inch, or 1 in 1,180,000; and that for the determination of a tape-length (= 299.079 feet, since the standard tape is from zero (0) to the 299-foot graduation of the tape) is $\pm$0.004 in., or 1 in 897,237 parts of a tape-length.

This latter probable error combined with that before given for the several bases would, of course, increase each to more than 1 in 1,000,000. But it is believed that the standard tape may be determined within 1 in 2,000,000 by direct comparison with the primary base apparatus, and that the probable error of a base-line measurement will then be less than 1 in 1,000,000.

ACCURACY OF THE LENGTH OF STANDARD TAPE FROM OLNEY BASE MEASUREMENTS.

No. Zinc.	Readings from Zincs.	z = Difference.	t Diff. in Temperature.	Corr. for Expansion.	z corr'd for $t = d$.	dd.
	IN.	IN.	DEG.	IN.	IN.	
0	+0.00					
1	+ .02	+0.01	−0.5	+0.01	+0.03	+0.0009
2	+ .04	+ 2	−0.5	1	+ 3	9
3	+ .05	+ 1	−0.7	2	+ 3	9
4	+ .06	+ 1	−1.5	4	+ 5	25
5	+ .03	− 3	−2.0	5	+ 2	4
6	+ .01	− 2	−2.5	6	+ 4	16
7	− .14	− .15	−2.7	7	− 8	64
8	− .20	− 6	−3.0	7	+ 1	1
9	− .29	− 9	−3.1	8	− 1	1
10	− .39	− .10	−2.9	7	− 3	9
11	− .49	− .10	−3.2	8	− 2	4
12	− .58	− 9	−3.2	8	− 1	1
13	− .68	− .10	−2.6	7	− 3	9
14	− .78	− .10	−3.1	8	− 2	4
15	− .85	− 7	−1.0	2	− 5	25
16	− .92	− 7	−1.0	3	− 4	16
17	−1.00	− 8	−1.9	5	− 3	9
18	−1.10	− .10	−2.0	5	− 5	25
19	−1.13	− 3	−1.7	4	+ 1	1
20	−1.24	− .11	−1.6	4	− 7	49
21	−1.28	− 4	−1.7	4	± 0	0
22	−1.32	− 4	−1.3	3	− 1	1
23	−1.34	− 2	−1.1	3	+ 1	1
24	−1.27	+ 7	−0.4	1	+ 8	64
25	−1.28	− 1	−1.0	2	+ 1	1
26	−1.31	− 3	−1.0	3	± 0	0
27	−1.31	± 0	−0.9	2	+ 2	4
28	−1.33	− 2	−1.3	3	+ 1	1
29	−1.27	+ 6	−0.3	1	+ 7	49
30	−1.30	− 3	−0.7	2	− 1	1
31	−1.33	− 3	−0.6	2	− 1	1
32	−1.32	+ 1	−1.1	3	+ 4	16
33	−1.41	− 9	−2.0	5	− 4	16
34	−1.49	− 8	−2.9	7	− 1	1
35	−1.53	− 4	−3.0	7	+ 3	9
36	−1.59	− 6	−2.5	+0.06	± 0	0

$\Sigma dd = +0.0455$

The probable error in the mean of the two measures of the base, considering the measurements as in 36 independent sections, is $= 0.6745 \sqrt{\frac{\Sigma dd}{4}} = \pm 0.0719$ in., and the p. e. of the east half of the Olney Base, not reduced to sea level, is $= \pm 3.215$ mm. $= \pm 0.127$ in.* Combining these two probable errors we have $\sqrt{(0.0719)^2 + (0.127)^2} = \pm 0.146$ in., and this divided by 36 gives the probable error in the value of the tape $= \pm 0.004$ in.; or 1 in 897,237 parts of the tape-length.

* See Professional Papers, Corps of Engineers, U. S. A., No. 24, pp. 287, 303, 304.

The Post-mortem Detection of Chloroform.

By Chas. Luedeking, Ph.D.

Presented before the St. Louis Academy of Science June, 1886.

In an important trial for murder recently held in St. Louis, the author of this paper made a chemical examination of the viscera of the victim, at the request of the coroner, and obtained very decided reactions for chloroform, notwithstanding the fact that the examination was not undertaken until about twelve days after death. The lungs, usually congested in case of death by chloroform, were selected as best suited for its detection. The great volatility of chloroform would seem *à priori* to preclude the possibility of its detection so long after death, and, as at the time there was considerable doubt expressed as to the reliability and accuracy of the experiments, the author determined, once for all, to decide the matter by direct experiment, and so set to rest all doubts.

The literature was first scanned carefully to ascertain whether there were any prior experiments in this direction, but nothing could be found. My direct object was then to determine how long after death chloroform can, with certainty, be detected; as also whether or no any substances are generated by the process of decomposition which might give similar reactions to chloroform, and thus lead to erroneous conclusions.

The manner of experimenting was simple and direct. Dogs of from 15 to 20 pounds weight were destroyed gradually by the administration of chloroform through the lungs in from 5 to 15 minutes; then the carcasses were allowed to stand in summer's heat or the temperature of the room for different periods of time, and finally the lungs removed and tested for chloroform by the Ragsky method.* In the following the experiments are briefly given:

Experiment I.—Carcass exposed on a dissecting table, during full summer's heat, for six days and ten hours. Decomposition far advanced and an exceedingly offensive odor given off. The lungs were removed,

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* Erdmann's Journal, **46**, 170.

and, after having been finely minced and rendered *slightly* alkaline by means of sodium carbonate, were heated over a water-bath in a flask, through which a current of air was slowly passing. The escaping gases were sent through a Bohemian glass tube, which was heated to bright redness over a space of two inches. The iodised starch-paper was five inches distant from this heated portion of the tube, and throughout the experiment remained perfectly cool.

A very strong bluing of the paper was observed and the nitrate of silver solution was strongly precipitated.

Experiment II. — Carcass exposed during full summer's heat for ten days. It had then lost all solidity, the hair literally falling off by the slightest abrasion. The lungs were removed and examined as in Experiment I. A very decided reaction for chloroform was obtained.

Experiment III.—Carcass was exposed during full summer's heat for fourteen days; the lungs then removed and examined as in Experiment I. The reaction for chloroform was very decided.

Experiment IV.—Carcass placed in an ice-chest for three weeks, and then exposed for ten days during full summer's heat. The lungs were then examined as in Experiment I., and a strong reaction for chloroform obtained.

I do not hesitate to say that in winter chloroform could be detected without the slightest difficulty for many months after death.

Experiment V.—Carcass exposed in a room (70° F., very constant) for three weeks and three days. The lungs were then examined as in Experiment I., and a very decided reaction for chloroform obtained.

Experiment VI.—Carcass exposed in a room (70° F., very constant) for four weeks; the lungs examined as in Experiment I., and a decided reaction for chloroform obtained.

The question now arises whether there cannot be substances formed by the process of decomposition, which, resembling chloroform in certain chemical reactions, might therefore lead to erroneous conclusions. Dr. Ragsky has already partially answered this question experimentally. The author made three experiments to this end, which are herewith briefly given:

Experiment I.—The lungs of a slaughtered bull exposed during full summer's heat for ten days. Not a trace of reaction of chloroform could be obtained by the Ragsky method.

Experiment II.—The lungs of a slaughtered bull exposed during full summer's heat for fourteen days. Nor a trace of reaction of chloroform could be obtained by the Ragsky method.

EXPERIMENT III.—Carcass of a dog destroyed by coal gas was exposed in a room (70° F., very constant) for three weeks and four days. No chloroform reaction could be obtained by the Ragsky method.

CONCLUSIONS.

1. By the process of decomposition no substances are generated which could vitiate the tests for chloroform by the Ragsky method.

2. Chloroform, when it has caused death by inhalation, can with certainty be detected in the body four weeks after death, and, notwithstanding its volatility, it is certainly retained in the viscera in large amount during this time.

In the case which was the cause of these experiments being undertaken, the victim had been dead at least ten days before the body was discovered, in high state of decomposition. On the strength of the Ragsky and Hofmann tests the author gave it as his sworn opinion that the deceased had chloroform in his viscera, whereupon a charge of murder by chloroform was preferred. Maxwell, the culprit, finally, after the lapse of an entire year, made confession that chloroform had indeed been the cause of death.

It being certain, finally, that chloroform can be detected a long time after death, as evidenced by our experiments we must next try to understand why this should be so. The following may serve to this end.

R. Dubois* finds that the vapor of chloroform penetrates into the interior of the tissues, and becomes substituted for normal water. This is not a phenomenon of dessication or osmose; a true affinity comes into play, the protoplasm absorbing the vapor of the anæsthetic and expelling a certain quantity of water.

Chancel and Parmentier† have proven that chloroform has a very decided affinity for water.

The author allowed to stand open a flask containing water, holding a small quantity of chloroform in solution. After two weeks' time the chloroform reactions could still be obtained without any difficulty.

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* Chem. News, 1886, 311.

† C. R., **100**, 27.

Add to the above that chloroform is a powerful preservative agent,‡ we have a collection of factors sufficient to enable us to understand the lengthy occlusion of chloroform in the animal body, though others of minor importance might be adduced besides these.

Grehant and Quinquaud,§ experimenting on dogs, find the amount of chloroform necessary to produce anæsthesia to be at least one gram to every two litres of blood. On the basis of these results, the total quantity of chloroform in the blood of a man of 150 pounds weight would be 2¾ grams approximately, when rendered insensible through its inhalation. The amount necessary to produce death would, under normal conditions, certainly not be less than this. Under the assumption that one-sixth of the entire quantity of blood circulating in the body is at all times passing through the lungs, the quantity of chloroform in the lungs of a man of 150 pounds weight, rendered insensible by its inhalation, would be about one-half gram.

We desire to emphasize by this calculation that there is an abundance of material in the lungs for the detection of chloroform. The liver would undoubtedly also be very suitable for its detection.

The Ragsky method is enormously delicate. One part of chloroform in one hundred thousand can still be detected by its means.

The method of A. W. Hofmann (Ber. Ber. 1871) is less delicate, and not available when the quantity of chloroform is less than one part in six thousand. However this is quite sufficient for toxical analytical purposes, and it should always be used as confirmatory of results obtained by the Ragsky method. When the tissues are much decomposed, the distillate obtained at first by means of the current of steam has a very powerful odor, which must be removed by repeated distillation with alcohol at as low temperatures as possible, and preferably under diminished pressure. By this means the first distillates will finally be sufficiently deprived of odor to enable successful application of Hofmann's test. Thus also the chloroform, which may have been present in very minute fraction in the original substance, can be concen-

‡ Robin and Augendre, C. R., **30**, 52; **31**, 679.

§ C. R. **97**, 753.

trated to a great degree, and reactions obtained under all circumstances decided enough to leave no doubt as to its presence.

For quantitative determinations of chloroform in chemico-legal examinations the method of Hager is better than that of Marechal, especially when the parts have undergone decomposition, and there is danger of distillation of other substances than chloroform which might reduce the Barreswil solution. Under the latter circumstances the Marechal method is not trustworthy and should not be used.

Hager's method, which depends npon the estimation of the chlorine of chloroform by converting it into hydrochloric acid by the action of nascent hydrogen, is applicable under all circumstances.

However, considering the great uncertainty of the action of chloroform upon the animal economy, actual quantitative determinations will hardly ever be necessary. Generally the mere determination of its presence will suffice.

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1 [33]

Tchikilli's Kasi'hta Legend in the Creek and Hitchiti Languages.

WITH A

CRITICAL COMMENTARY AND FULL GLOSSARIES TO BOTH TEXTS,

BY

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Νᾶφε καὶ μέμνασ' ἀπιστεῖν·
ἄρθρα ταῦτα τᾶν φρενῶν.

EPICHARMUS.

PREFACE.

The investigation of the ancient reports on the migrations of tribes and nations counts among the most difficult problems of ethnologic science. The fact itself that certain peoples and tribes have migrated to distant countries admits of no doubt, but the authors who transmitted the reports had them from hearsay only, and tradition is never so trustworthy as accounts written down contemporaneously with the facts. Without an exact chronology there is no historiography, but traditions and legends are caring little for chronology; proper names of persons and localities in them disappear from memory, because they are difficult to remember. From fortuitous coincidence of names etymologic legends come to the surface, like the story now current in the west, that the Yuchi tribe have once separated from the Utes (Yuta) and travelled east.

A similar baseless story concerning the migration of the Creek or Maskoki people from the west is contained in Milfort, "Mémoire sur la nation Creek," Paris, 1802, pp. 229 sqq., the work of an author who had lived among the people for many years. He pretends that the Creeks or "Moskoquis," as he calls them, once formed a separate people in the northwest of Mexico, and, when Montézuma was attacked by Cortes and his troops, succored him; they were vanquished, and preferred emigration to some distant land to abject slavery. They marched to the Red river of Louisiana, became involved in a conflict with the Alibamu Indians, and, while pursuing them, arrived in the country held by them afterwards and settled there. The origin of this curious mystification lies in the circumstance, that all the wild and hunting tribes in the north of Mexico and from Florida to California were called *Chichimecs* by the uneducated part of the Spanish immigrants, after a half-savage people of mountaineers near Anahuac. The French colonists obtained this name from Spaniards of the Rio Grande or of Pensacola, who applied it to *all Indian tribes east and west* of the Lower Mississippi. The Cenis or Assinai, for instance, were regarded as inhabitants of the "province de Chichimèque" (Margry, Déc. iv. 547) about the year 1700, and the primitive Chicasas were considered as Chichimecas as well (Adair, Hist. 195, 197). Now it was a current tradition that all tribes of the Maskoki family had come from the west; being considered as Chichimecs, from what other part could they have come except from Mexico, the old home of that people? So the invented story became plausible and was generally believed in, if not by all Indians, at least by the colonists.

We may add to this a number of fantastic reports on Indian emperors and empires, war expeditions, splendid capitals and temples, inaccuracies about the languages spoken by certain tribes, far-going ethnologic speculation founded upon insufficient evidence, and relating frequently to the origin and provenience of certain tribes and the American race in general. The works of Adair and DuPratz, though otherwise of high value, contain many misstatements of this kind, and their manner of considering dry facts and real occurrences is often blurred by these views. Chroniclers, explorers and even state documents are not free from misstatements on the condition of the Indian in colonial times. In many respects the old men among the Indians now living are the safest guides for these ethnologic problems; but many traditions and other points of interest also escape their memories, and we have to fall back again on the early authors with all their prejudices and oddities.

To find out the truth from all the fictions and contradictions only one pathway lies open to us that may lead to safe results concerning migrations in general, and the Kasi'hta migration, which forms the subject of these pages, as our special object of research. It is historic criticism applied by means of the comparative method. The process is lengthy, cumbersome and not without serious difficulties, for the ethnography of many American tribes has to be investigated, sifted and compared to arrive at this end.

These pages were composed for a purely scientific purpose to aid the studies of the more earnest seekers after historic truth in Indian matters. Its contents and style will scarcely suit the taste of readers spoiled by the sensational press and literature of our days, for what I have gathered is an array of *facts* only, which will speak for themselves to those able to grasp their meaning. Especially the results to be gathered from *linguistics* can only be grasped by attentive perusal and study, and not by desultory reading.

America, with its numerous cities and states now flourishing upon a soil which was once the undisputed domain of the Indian race, owes it to its aboriginal population to investigate their history, languages and ethnic peculiarities with fairness and veracity. To this lofty purpose I have endeavored to contribute by studying one of its most conspicuous nationalities, that of the Creek Indians. It is fervently to be wished for, that educated Indians arouse their own race from its apathy, and strive to reclaim the memory of the deeds and languages of their warlike ancestors from undeserved oblivion. With some scientific training they can easily outdo the studious men of the white race in this, for their facilities in gathering facts and performing the work are largely superior to ours.

THE AUTHOR.

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THE MIGRATION LEGEND OF THE KASI'HTA TRIBE

is one of the most fascinating legendary accounts that has reached us from a remote antiquity, and is mythical in its first part. The Kasí'hta tribe, among which it originated, had a considerable town of the Lower Creek Indians on Chatahutchi river, eastern shore, and with its three branch villages counted about 180 heads of families in 1799. It was built at the junction of Apatá-i creek with Chatahuchi river, at a short distance from Yuchi and Kawíta towns. A passage in the legend accounts for the fact, that Kasí'hta was at Tchikílli's time regarded as the most influential, most honored town of the Lower Creeks, or, as he expresses it, "*the oldest.*" B. Hawkins, United States agent of the Creek Indians and author of a "Sketch" composed in 1799, gives interesting particulars about the town (pp. 58. 59; published by Ga. Hist. Soc. 1848). The Creek Indians, of whom the Kasí'hta were a part, formed the central people of the Maskoki race and linguistic family, and were subdivided into Upper Creeks (on Coosa and Tallapoosa rivers) and Lower Creeks (on Chatahuchi river and affluents); they formed a political body and defensive league called the Creek Confederacy. The other divisions of that linguistic family were the Cha'hta with Chicasa, the Alibamu and Koassáti, the Hitchiti-speaking towns on Lower Chatahuchi river, Flint river and east of it; the Seminole Indians, who speak either Creek or Hitchiti, the extinct Yámassi and Yamacraws, and, lastly, the Apalaches, once near St. Mark's river, Florida.

Tchikílli, the head-chief of the Upper and Lower Creeks, delivered the legend in an allocution held before Governor James Oglethorpe, at Savannah, Georgia, in the year 1735. The British colonial authorities and people were present, and also some sixty men of Tchikilli's Indian retinue. After delivery, the interpreter handed it over, written upon a buffaloskin, to the colonists, and the same year it was brought to England. It appears from an article in the "American Gazetteer," London, 1762, vol. ii., Art. Georgia, that the contents were written in red and black characters (pictographic signs, we suppose), and that afterwards it was hung up in the Georgia office, in Westminster, London. Upon Dr. D. G. Brinton's request, Mr. Nicholas Trübner sought to trace this pictured relic in the London offices, but without success. The text of the narrative has been fortunately preserved in a German translation, and this is far more important for us than the preservation of the painted buffaloskin would be. It is found in a collection of German pamphlets treating of American colonies, published from 1735 to 1741. The title of the first volume runs as follows: *Ausfuehrliche Nachricht von den Saltzburgischen Emigranten, die sich in America niedergelassen haben. Worin, etc. etc.; herausgegeben von Samuel Urlsperger, Halle.* MDCCXXXV. Our legend is contained on pp. 869 to 876 of this *first* volume, and forms the *sixth* chapter of Von Reck's "Journal," the title of which runs as follows: *Herrn Philipp Georg Friedrichs von Reck Diarium von Seiner Reise nach Georgien im Jahr* 1735. This officer had been the commissary of the German Protestant emigrants, whom religious persecution had expelled from Salzburg, the capital of Styria, their native city.

After Dr. Brinton had discovered the legend in that collection and studied it, he prepared a publication on the subject, which appeared in the "New York Historical Magazine," Morrisania, April, 1870, under the title, "The National Legend of the Chahta-Muskokee Tribes," 13 pp. This article also embodies a shorter narrative of the same legend, preserved by B. Hawkins in his "Sketch," pp. 81–83, which is instructive in many respects, and locates the place where the Kasi'hta, Kawita and Chicasa "originated," west of the Mississippi river. In translating Von Reck's account into English, Dr. Brinton made some slight mistakes, to be indicated below. His English rendering is reproduced in this volume and formed the basis for the *retranslation of the legend* into the Creek and the Hitchiti dialects, which was satisfactorily accomplished by my friend, Judge Geo. W. Stidham, who is a born Hitchiti Indian, now residing in Eufaula, Indian Territory. I have subsequently revised the Indian texts, and especially the glossaries, with the aid of other Indians familiar with the same dialects.

THE LIST OF SOUNDS

occurring in the Maskoki dialects is, according to my scientific alphabet applied in this volume, as follows:

The sounds *b*, *d*, *h*, *k*, *l*, *m*, *n*, *p*, *t* are pronounced in the same manner as in European languages. *N* superior marks nasalizing of the vowel preceding: *aⁿ*, *oⁿ* as in French *écran*, *bon*. The macron marks the longer sound of vowels, as *ā* in *father*, *ē* in *shade*, *ī* in *reef*, *ō* in *note*, *ū* in *fool*. Long sounds are often the result of accentuation. The crescent marks the shortest sound of vowels: Cr. hăsi, *sun;* nĭ'ta, *day*. A distinct sound is given to ĕ. The diphthongs being adulterine, they can be generally separated into two vowels, and then become hyphenized:

i-u, *o-i*, *á-i*, *a-ú*.

a as in *alarm*, *wash*.
á as in *fall*, *law*, *taught;* same sound as *ó*.
ä as in *dash*, *rat*, *slab*.
e as in *bell*, *met*.
ĕ as in last syllable of *maker*, *settler*.
g as in *gamble*, *garfish*, *gum;* never as in *apogee*, *geology*.
dsh as heard in *judge*, *dudgeon;* alternates with *tch*, *ts*, *ds*.
h as in *hard*, *hook;* when medial and final, it was written *'h* to prevent its being pronounced as a silent letter.
i as in *marine*, French *ici*.
ĭ the *i* pronounced deep or hollow, as in *brim*, *filth*, *still*.
y as in *yell*, *yoke;* never used as a vowel.
χ the aspirate guttural — in German, *lachen*, *sachte*, as pronounced in Southern Germany; in Spanish, *mujer*, *dejar:* in Scotch, *loch*. It alternates in Maskoki with the alveolar *g* and *k*, and has nothing in common with the English *x*.
'l the *l* palatalized, as in 'láko, *great;* 'lá'lo, *fish*. *L* is pronounced while the tip of the tongue is held against the fore-palate. Transcribed in the Creek missionary alphabet by *r*, in that of the Cha'hta by *hl*. This singular sound occurs in all Maskoki dialects, in Yuchi, Naktche and Cheroki (here it alternates with *tl*), in Caddo and many tongues of the Pacific coast; but not in Tonica, Shetimasha, Timucua and Katába.
o as in *most*, *lost*.
s as in *sour*, *smart;* alternates with *sh*.
sh as in *shift*, *mash*.
tch as in *catch*, *church;* alternates with *ts*, *dsh*, *ds*.
u as in *truth*, *soothe*.
ŭ the *u* pronounced deep or hollow, as in *gull*, *sullen*.
w the ú before vowels, as in *water*, *wolf*.

For permutations of sounds among each other, observe that *d* alternates with *t*, *b* with *p*, *g* with *k*, *χ*; *o* with *u*, *s* with *sh*, *tch* with *ts*, *dsh*, *ds*. Remember this well when using the glossaries.

The English *x* is rendered by *gs* or *ks*, the German *z* by *ds* or *ts*, all being compound articulations. The two points on *a* (*ä*) mark a softened vowel, and are *not* a sign of diæresis.

GRAPHIC SIGNS AND ABBREVIATIONS.

'	apostrophe—used (1) for marking elision of a vowel, of *ĕ* or any other sound; (2) before *h*. See *h* in List of Sounds.
-	hyphen separating two vowels as belonging to two different syllables; it is also placed before some affixes.
-	hyphen separating the parts of compound terms.
′	acute; the only accent used for emphasizing syllables.
‒	*macron;* indicates length of a vowel, *ā*, *ō*, etc.
˘	*breve;* indicates a short vowel, *ă*, *ĭ*, etc.
cf.	compare.
coll.	collective form.
Cr.	Creek dialect.
der.	derivation, derived from.
H.	Hitchiti dialect.
p., *pp.*	page, pages.
q. v.	*quod vide*, *quæ vide* (reference to another or other terms).
sqq.	and the line or pages *following*.

Italicized words in the English translation are left out in the Creek text.

The blackfaced page-numbers occupying the corner of each page are the only figures for the reader to refer to, and from these all quotations were made. The other figures enclosed in brackets give the current paging of the present volume of the Academy's Transactions.

THE CREEK TEXT.

ÍSTI MASKÓKI ADSHULAGI-TÁTI INNAꞁUNÁꞁAT OS:

Náki Tchikílli ísti Maskō'ki Hatchapála'h Hatcháta tipā'χad ímmikut hammā'kit opunáyatīs Sawā'na talófan, o'h'lolopí tchúkpi 'láko hámgin tchúkpi kulapákin páli-tut'tchínin tsáχgi puχgákin; mómen i-ätikóyatis, mó'hmen yanas-há'lpin uχhutsä'hudsatis.

Tchikílli ísti Maskō'ki Hatchapála Hatcháta típākad ímmikut; Ántitchi Káwitalgî í'mmiko máχit, Íllídshî míkko; ósta Kasíχtalgi îmmíkko, Támmidsho hú'li míkko; Wáli Apala'htsuklálgi hú'li kapitáni, Puipaédshi míkko: Támhuitchi Yutchitálgi imífa míkko: Mitikáyi Okū'nalgi inhú'li míkko, Tuwidshédshi míkko; Huꞁáni Tchiyáhalgin Okmulgálgi tibáχad ínhu'li míkko; Stimalagué'htchi Osotsálgi immíko; Hupí'li Sawoklálgi îmmíkko; Iwanágî míkko; Tamókmi Yufantálgî inhú'li kapitáni tún, tustanoχálgî páli-tut'tchínit apákin opunáyit ókatis:

Mómad níta ō'dshin íkana idshókuat hásî-aklatgátin ō'dshit ō'men hawáχladīs; mómof man Kasí'htalgi ikandshóχuan ä'sosa-id anákuasin inkákîda háyatis tché. Mú'mof íkanat tchapáka-ikit hopuitákin inlóχadis; ma mō'man akúyi'htchit inhas-aχlátkosin apóχadīs; mómäs apálluat i'láfuli'htchit mátăwan i-apóχadis. Mómäs ísti súlgad í-upan fik'húnnatis; "múmaχan hí'lit-wōtis" kómākika. Múmitu istómäs í'kana hubuitágî înlóχatid imomitchä'dshin, inhí'lîkût hási-óssāti fátchan apíyatīs.

Mó'hmit apíyît oí-ua tchíkfi okû'fki lipákfit wággin u'léχtchît, hápû háyit fígabin u'hhayátgadis. Í'lin háyatgi apíyît ní'ta hámgad yáfgadîn uíwa tsá-atid wággin u'lé'htchadīs. Mó'hmît man apógit u'h'lolopí hokólin 'lá'lotäs man pasátit pápit apókatis. Múmäs wi-kä'wat inhi'lágikun inhi'lagigádis. Úyuwa tchádad iyúksa fádsan apíyadīs, mó-

TRANSLATION.

WHAT CHEKILLI, THE HEAD-CHIEF OF THE UPPER AND LOWER CREEKS SAID, IN A TALK HELD AT SAVANNAH, ANNO 1735, AND WHICH WAS HANDED OVER BY THE INTERPRETER, WRITTEN UPON A BUFFALOSKIN, WAS, WORD FOR WORD, AS FOLLOWS:

[*Speech, which, in the year 1735, was delivered at Savannah, in Georgia, by*] *Chekilli, Emperor of the Upper and Lower Creeks; Antiche, highest Chief of the Town of the Cowetas, Eliche, King; Ousta, Head-chief of the Cussitaws, Tomechaw, War-king; Wali, War-captain of the Palachucolas, Poepiche, King; Tomehuichi, Dog-king of the Euchitaws; Mittakawye, Head War-chief of the Okonees, Tuwechiche, King; Whoyauni, Head War-chief of the Chehaws and of the Hokmulge Nation; Stimelacoweche, King of the Osoches; Opithli, King of the Jawocolos, Ewenauki, King; Tahmokmi, War-captain of the Eufantees; and thirty other Warriors.*

At a certain time the Earth opened in the West, where its mouth is. The Earth opened and the Cussitaws came out of its mouth, and settled near by. But the Earth became angry and ate up their children; therefore, they moved further West. A part of them, however, turned back, and came again to the same place where they had been, and settled there. The greater number remained behind, because they thought it best to do so. Their children, nevertheless, were eaten by the Earth, so that, full of dissatisfaction, they journeyed toward the sunrise.

They came to a thick, muddy, slimy river—came there, camped there, rested there, and stayed over night there. The next day they continued their journey and came, in one day, to a red, *bloody* river. They lived by this river, and ate of its fishes for two years; but there were low springs there; and it did not please them to remain. They went toward the end of this bloody river, and heard a noise as of thunder. They approached to see mof tinī'tki ō'kin impóhatis, nákitoha kó'hmet uχ'hapíadis. Múmad íkodshi tchátit 'lánin óssît ómātit ókin hídshatis; mómad ma 'laní únapan yahaíkîda ókid pohákatis. Nágîtun ómad "hí'htchagīs" kä'χtchid, ísti uχtútatis; múmatin tótka 'lákid hálluin álîgapit ómātit mat yahaíkida ókit ómin hidshákatis. Í-a 'láni 'láni immíkkun kaítchîd hodshífatis. Háyumäs tinítki imúngis; mō'men ísti impingalagí imúngat ō'mis.

Man ístì itáloa ma'lá χ'la χa tut'tchínin itihídshatis; mómad ma 'láni tútka óssi ō'dshan ahitídshatit isfúllin itihídshatis; mó'hmet man imáhilissua ómäs inhī'tchkin náki íta-u súlkin ahupu'llinákatis.

Hă'si-óssati fátsan átit tútka hátkîd immalā'katis, mómäs istomitchakigátis. Wahála fátsan átit tútka okulátid immalákatis, múmäs má-o istomidshikátis. Akŭlátka fátchan atít tútka lástid immalákatis, má-o istomidshikádis. Ispógi húni'la fátchan atít tútka tchá-atitut láuit immalákatis. Hía tótka 'láni ahī'tki ō'dshi ahitídshi ísfullatid ituχkálan; hía tótkan háyomi atíkäs ō'dshit ō's. Má-o yahá-iki ómäs ódshid ómis. 'Laní únapan púkabit úχui'lit ómatît fik'hí'lkîgût istukä'idshi máhid ómatin, istä'mat ísto'hmit ómatin "fík'hunnīs máχäs" sîgátis. Ístûdshi ī'tski-súsikōn ma ítun i'lanafaí-kit ilíhotchatis; mó'hmet ma púkabî í'hsit hó'li apíyatäs isfúllatis. A tássa ómid ćnatis; háyomäs ódshis ma ómid. ito-ú'h mátawat ómatis.

Hiátawan nákî i-alúnga ma'láχ'laχă ō'stid yahaígit îstumítskatad i-uχki'lkuídshit ódshîn inhítchkadīs; ihatitchíska: pássa; sahokólad: mikko huyanídsha; satot'tchínad: sawátsku'h; isústad: híshi lopútski; hayómit inhítchkadīs. Imáhilissua inhítchkadi pō'skat pássa míkko hoyanídsha tipákan isiafástid ómants. Hía púskita o'h'lolopí omálgan i-ilawídshit náki hóma lóktsat atígat man wéyit ómis. Ma imáhilissua inhitchékadi áyat húktagidēs ípuskīs, mómin ómad tútka ítäman i'la-itídshit apókin nĭtá tsaχgípäs, ípakäs, kulapáχäs ó'lin inhuyánad i'la-áwīd ómatis. Hían múmikun ú'mad imahilíssuatäs imahopánid ómĭka; mómin hóktage-u'h tchafíndshagigō hakitáyid ómika.

Ma-ómofa máhin ísta itáluat adsuleidshítût ómit homáχ'hotit innakmágit shihóki-titáyiha kómitan itimayopóskit whence the noise came. At first they perceived a red smoke, and then a mountain *which thundered;* and on the mountain was a sound as of singing. They sent to see what this was; and it was a great fire which blazed upward, and made this singing noise. This mountain they named the King of Mountains. It thunders to this day; and men are very much afraid of it.

They here met a people of three different Nations. They had taken and saved some of the fire from the mountain; and, at this place, they also obtained a knowledge of herbs and of many other things.

From the East, a white fire came to them: which, however, they would not use. From Wahalle came a fire which was blue; neither did they use it. From the West came a fire which was black; nor would they use it. At last, came a fire from the North, which was red and yellow. This they mingled with the fire they had taken from the mountain; and this is the fire they use to-day; and this, too, sometimes sings. On the mountain was a pole which was very restless and made a noise, nor could anyone say how it could be quieted. At length they took a motherless child, and struck it against the pole; and thus killed the child. They then took the pole, and carry it with them when they go to war. It was like a *wooden* tomahawk, such as they now use, and of the same wood.

Here they also found four *herbs or* roots, which sang and disclosed their virtues: first, Pasaw, the *rattlesnake root;* second, Micoweanochaw, *red-root;* third, Sowatchko, *which grows like wild fennel; and* fourth, Eschalapootche, *little tobacco.* These herbs, especially the first and third, they use as the best medicine to purify themselves at their Busk. At this Busk, which is held yearly, they fast, and make offerings of the first fruits. Since they learned the virtues of these herbs, their women, at certain times, have a separate fire, and remain *apart from the men* five, six and seven days, *for the sake of purification.* If they neglect this the power of the herbs would depart; and the women would not be healthy.

About that time a dispute arose, as to which was the oldest, and which should rule; and they agreed, as they were four Na-isihóχatis. Itáluat ō'stîga púkaben tchaktchahí'htchid: "fáki dshádin istchaditchagí'hlis; lánitut ómäsim nikʻlúfat tchátit ómika" mákakadis. "Mumíh'tchid pónhoʻli ilî'tchkan apíagiʻl, mû'men ísta itálua-tátit istigaháʻlpi yaweíkit, ítu tchaktchahídshati û'hlánin ómat, mad atchúllīd ómaʻlis," itikä'dshadis.

Omálgat momítchita kómît, ómäsim Kasiχtálgî-tá'htit yawaígit pókabi aksomidshä'χtchin hítchgigō háχadis. Mómiga mat itállua adsúlli máhad ómis komhuyidádis. Tchikasálgit awaíhîgadis, mómen Atilámalgi iʻla-aweíhigadis; múmäs Abiχkánagitawat u'hʻláni ayídshädshad isti=tóʻlkua atíkusi-táyin yawaígadīs.

Ma-ómof fû'suä ok'holátid ʻlákid áʻlatis; ihádshî tchápgīd, ímpafnita lámhi imántalidshid. Níta umálgan alágit ístin pasátît pápît áʻlatis. Hókti ahákin háhit, hía fúsuă áʻlatin ihuiläidsháχadis. Hía fúsua ma nákî inhahóyadi í'hsit isayipatítut, hofónen iʻlisaláχatīs. Ódshipin ómad nákitäs hítchkuidshi wäítis kómakatis. Hofóni hákin tchíssi tchátit hi'tchkatis; mómen ma fúsuat iʻlkitó-aitis kómaχatis. Ma tchíssin itimpunayágit istumidshakátit íʻlgi imilidshagi-táyad itimpunäyákatis. Ma fúsuă ítcha=kuadáksin ínʻli apákīn ō'dshid ómatis. Mómen ma tchî'ssit ítsa=kuadáksi îfákan kalágit intádshatis, istómit issi-imanäítchiko-tidáyin háyatis; mómen man ilidsháχatis. Ma fúsuă fúsuă ómal immíkkun käidsháχatis. Lámhi-u míkko ʻlákid ō'mis kómagid ómis; mómiga húʻlidäs apíyis, adám híʻlka hákadäs fúllis mómof lámhihádshi ko'htsaktsahídshid isfúllid ómis. Tchátad hóʻlit ómin, hátgātît híʻlka ahopákat ómis. Ihúʻlit táfa hátkin isnihäídshit idshú'kuan hatídshit awolä'dshit lámhi ókit hákin ómat, istófan ilí'htchikos.

Hia nági mú'hmōf íyupan ma apókati inkapáχkit apívit níni hátkid wákin oʻläítchatis; páhitäs nak=omálgat hátkusiálgid ómatis. Mómen ístit fúlli=híʻlit ómadin idshákadis. Ma níni ituhualapíχtchit anákuasin nodsä'dshadis. Iʻlafulíχshit nínî istómid ómad yihidsháχadīs, mómit ísti istómid fúllit ómati, ma nî'nîn atíχgit atchakapiyakátin isámumides ó'hmis kómit ómadīs. Man atihäígit apíyit Kolós'hatchi mágidan ak'hadapídshatis; Kolós'hatchi kédshad tchadûálgid íkodshid ómĕka.

tions, they would set up four poles, and make them red with clay, which is yellow at first, but becomes red by burning. They would then go to war: and whichever Nation should first cover its pole, from top to bottom, with the scalps of their enemies, should be the oldest

They all tried, but the Cussitaws covered their pole first, and so thickly that it was hidden from sight. Therefore, they were looked upon, by the whole Nation, as the oldest. The Chickasaws covered their pole next; then the Atilamas; but the Obikaws did not cover their pole higher than the knee.

At that time there was a bird of large size, blue in color, with a long tail, and swifter than an eagle, which came every day and killed and ate their people. They made an image in the shape of a woman, and placed it in the way of this bird. The bird carried it off, and kept it a long time, and then brought it back. They left it alone, hoping it would bring something forth. After a long time a red rat came forth from it, and they believe the bird was the father of the rat. They took council with the rat how to destroy its father. Now the bird had a bow and arrows; and the rat gnawed the bowstring, so that the bird could not defend itself, and the people killed it. They called this bird the King of Birds. They think the eagle is also a great King; and they carry its feathers when they go to War or make Peace: the red mean War; the white, Peace. If an enemy approaches with white feathers and a white mouth, and cries like an eagle, they dare not kill him.

After this they left that place, and came to a white foot-path. The grass and everything around were white: and they plainly perceived that people had been there. They crossed the path, and slept near there. Afterward they turned back to see what sort of path that was, and who the people were who had been there, in the belief that it might be better for them to follow that path. They went along it to a creek called Coloose-hutche, that is, Coloose-creek, because it was rocky there and smoked.

Ma hátsi tayíχtchit apíyît hási=óssati fátchan, Kósa mágida italluat apókin iʻlimuʻläítchatis; hían apókin o'hʻlolopî' ostad óʻladīs. Kósalgit ókātit "isti=pápat tchátu haúkin paíkīd, ístin pumpasátit, omítutanks" mákatis.

Kasiχtálgit ókātit illídshida kómid hídshi-is máχadis. Íkanan kuʻla-ít údshiháʻlpin húyan háhid isúχʻlanatis. Mó'hmit to=lopótskin o'htalalaítchatis, ma isti=pápa adshákayigō-titáyin háhit u'hapíyadis; mó'hmit sá-okan ma tcháto haúki isti=pápa paíkan iʻlimuhueíkatis. Ma isti=pápa tsabaki=híʻlit a-osä'-iyit ássidshatis afósalgat itíʻlaputit. Ísti hámkûsit ílātin ahíʻlit ómīs omálgi mahátin mónks kó'hmit, ístudshi ítski=sósikōn imawaigákatis íkan=haúkin awoläídshit at ófan. Mán isti-pápa o'hlitäígit ígan=haúki inhayákatin u'hlatäíkin, tsul=íkûsua ahít'hukin isnáfkit ilidsháχatis. Ifúni hayúmäis isfólli imúngat ō'mis. Pal=hámgad tsátitun, pal=hámgit ok'holátid ómis.

Isti=pápa níta iskulapák' omálgan iʻlalágit ísti pasátit ómatis. Múnga ma ilí'htchuf mátawan fík'hunnin níta kolapágī óʻlin iʻliétchat s. Ma isagiʻlétchkan hóʻhtäs apiaʻlánit i-ititákuitchat nĭtá ípagin imapóskit iskulapákatin apíyid ómatis. Ifónin i-ahuʻlkasítchid isapí-in ómad ihítski=híʻlin fúllid ómis.

O'hʻlolopí ō'stad óʻlin Kósa talófa apókati ingapáχkit apíyat hátchî, Nófāpi ká-etchid, uʻläítchatis, yómad Kalasihátchi kä'hodshid hákit ōs. Man u'hʻlolopí hokólin fik'hunnadīs. Mómid ádshidäs ódshikoka, náki yelúngan ʻláʻlun yómen humpáχatīs, mómit itcha=kutáksi háheidshit inʻlitáti itchhásua înútin ʻlonótutäs, yómān siyokfanfaédshit kúha=tuká'hlin isláfka háyatis.

Hía apókati inkapáχkit apíyad hátchî Watulahági mákitan oʻläítchatis. Watulaháki Hátchi käídshad wátulat-tidáyit látkid ómit háhokadin ahudshífît umhóyadīs; man níʻli, hámgin nodshä'dshatis. Hadám apíyad hátchi oíwa u'hlátkid ódshin uʻläídshatis; O-itúmkan hotchífadīs. Iʻlín hayátki hátchi hámgin uʻläítchatis Afosafíska kē'dshid.

Iʻlín hayátki ma hátchin tayíχtchit apíyad ʻlăni hálluit läíkin uʻläítchadin, ístit apókin hídshatis. nínî hátki háyi fúllangid ō'mis kómatis. Múnga ʻli hátkin háhi-it ísitchhatis, ísti hiʻlágīt ómin ómad gíʻlidan kómidut. Mómäs ʻlí

They crossed it, going toward the sunrise, and came to a people and a town named Coosaw. Here they remained four years. The Coosaws complained that they were preyed upon by a wild beast, which they called man-eater or lion, which lived in a rock.

The Cussitaws said they would try to kill the beast. They digged a pit and stretched over it a net made of hickory-bark. They then laid a number of branches, *crosswise*, so that the lion could not follow them, and, going to the place where he lay, they threw a rattle into his den. The lion rushed forth in great anger, and pursued them through the branches. Then they thought it better that one should die rather than all; so they took a motherless child, and threw it before the lion as he came near the pit. The lion rushed at it and fell in the pit, *over which they threw the net*, and killed him with blazing pine-wood. His bones, however, they keep to this day; on one side, they are red; on the other, blue.

The lion used to come every seventh day to kill the people; therefore, they remained there seven days after they had killed him. In remembrance of him, when they prepare for War, they fast six days and start on the seventh. If they take his bones with them, they have good fortune.

After four years they left the Coosaws, and came to a river which they called Nowphawpe, now Callasi-hutche. There they tarried two years; and, as they had no corn, they lived on roots and fishes, and made bows, pointing the arrows with beaver-teeth and flint-stones, and for knives they used split canes.

They left this place, and came to a creek called Wattoolahawka-hutche, Whooping-creek, so called from the whooping of cranes, a great many being there; they slept there one night. They next came to a river in which there was a waterfall; this they named the Owatunka river. The next day they reached another river, which they called the Aphoosa pheeskaw.

The following day they crossed it, and came to a high mountain, where were people who, they believed, were the same who made the white path. They, therefore, made white arrows and hátki tchatakué'htchit iʻlásidsh'hatis. Mú'hmen ímmikûn hidshédshaχadin "híʻlikut ōs" mákatis; "ʻlít hát'hagid iʻlaf ulídshin ō'mad u'hapíhi-id íhaliwa úmûsäs, hupuitági ihitchkuídshit iʻlásawa anátchkatis, múmäs tchátidûga u'hapíhiatskas" käídshatīs. Mómi istómäs ísti istómid omákat hítchitan kómit u'hapíyi sásatis; mû'matin sumitchípin oʻläítchatīs. Nínit ó-i⸗ʻlákun akadápgid ō'min hidsháχadis, mómadit má nīni tabála iʻlússigōd ómin, hídshit má ísti úyuan isáktchiyit, ómiga iʻlasosa-igōs kómadis.

Mán ʻlánit läígid ómis Mō'terell mágität; mû'madit aʻlkasatúlga nafhúgīs ma-úkid hákid ómīs, mómin má ísti mán apógit ómadshōks kúmhuid ōmīs. Húʻlidäs apíyit fúllin ómofa, hía inhági istamaítäs pō'χki álgīn pohágît fûllid ómis.

Má úyuan apa-idshídshit apíyit ú'hlatkīd ódshin oʻläítchadin, tchátu ʻlákʻlagid ódshin hídshatis, man itcha⸗χûdáksit o'hlómhin hídshadīs; mómit má ísti nînî hátki háyi fúllangid ómadshuksh kómatis.

Istófäs ístan apíyit fúllāti hóman ísti hokólin wiláko-idshit fúllid ómīs. Hía húma⸗wilákad ʻláni hálluin o'htchimhókadin talófat ódshin hídshatis. ʻLi hátkin ma talófa isítch'hatis; múmäs ma ísti talófa atíχkad ʻlî-î tchátin asítch'hatis. Mómof Kasí'htalgi tchapák'hoχatīs, mú'hmit "ma itáluan isapingalídshin ómof tchókō isi-titayipíalis" kómatis. Tchádun úyuan akpalátit täígagi-titáyin háhi-it u'htäyídshatis; mó'hmit talófan imísatis. Ma ísti íka tapikstagīd omáχatis; umálgan pasátit hokólĕsĕn ahusitchä'tchatīs. Ássitchi isápiyad, ífa hátkin is'hí'htchit illídshatis. Hokólusi ahō'skadin assídshit isapíyad, níni hátkid wággin oʻläítchadin, talófat odsatchúkit íkodshin í'htchit, hía ísti hidshída kómi hopo-iyitángid ómadshoks kómatīs. Hían Palaχtchuklálgi apókit ōs; mō'men ma oχ'huanápsīd Tamodsä'-idsi ómīs.

Kasi'htálgi imagiʻläítska tcháti palátkan i-ádshid emúnkatis; mómäs Palaχtchuklálgit ássin iskuídshatis híʻlkida isahopákan, mó'hmit imponáyatis: "pófigi hat'hágid ōs, mómin tchíme-u matapómaʻlis podsû'shuădshi tcháti-algátin takwagíχtchit; istchigíʻlgáʻli tchinátakin hat'hē'dshaksh!" ka-édshatīs. Mómidû istómäs podshû'shuadshin ayíktchi imúnkatis; Palaχtchuklálgit isawäitchítchikut imî'hsit intubá lídshan hopílatis Palaχtchuklálgit táf⸗atkin ímatis, mó'hmit shot them, to see if they were good people. But the people took their white arrows, painted them red, and shot them back. When they showed these to their chief, he said that it was not a good sign; if the arrows returned had been white, they could have gone there and brought food for their children, but as they were red they must not go. Nevertheless, some of them went to see what sort of people they were; and found their houses deserted, They also saw a trail which led into the river; and, as they could not see the trail on the opposite bank, they believed that the people had gone into the river, and would not again come forth.

At that place is a mountain, called Moterell, which makes a noise like beating on a drum; and they think this people live there. They hear this noise on all sides when they go to War.

They went along the river till they came to a waterfall, where they saw great rocks, and on the rocks were bows lying; and they believed the people who made the white path had been there.

They always have, on their journeys, two scouts who go before the main body. These scouts ascended a high mountain and saw a town. They shot white arrows into the town; but the people of the town shot back red arrows. Then the Cussitaws became angry, and determined to attack the town, and each one have a house when it was captured. They threw stones into the river until they could cross it, and took the town (the people had flattened heads), and killed all but two persons. In pursuing these they found a white dog, which they slew. They followed the two who escaped, until they came again to the white path, and saw the smoke of a town, and thought that this must be the people they had so long been seeking. This is the place where now the tribe of Palachucolas live, from whom Tomochichi is descended.

The Cussitaws continued bloody-minded; but the Palachucolas gave them black drink as a sign of friendship, and said to them: "Our hearts are white, and yours must be white, and you must lay down the bloody tomahawk, and show your bodies as a proof that they shall be white." Nevertheless, they were for the "púmmikût hámgushikas" käidshatīs ; mú'hmati atígad istófäs itoχkálgit apóki imúngatātīs.

Ú-i⸗'láko pala⸗hámgin apóki sásin, apáluat tapálan apóki sásatis. Apóki hámgad Kasíχtalgin kä'dṣhit, apáluan Kawitálgin kähódshid ómīs ; mómäs ísti hámgûsid ómis, mómit Hatchapála Hatcháta tipáχad ísti Maskō'ki itálua homáχhotid ómis. Mómidu istómäs Kasíχtalgi táχtit íkuădshi tcháti, tútka tcháti hídshatit ómit, itálua tcháti-u háyatit ómika. îfîgi tchátadi wäika'lúngo imúngat ómis ; muntúmäs pala⸗hámgad hátkid⸗un, pala⸗hámgit tchátidut ómäsim. Hä'yomat nînî hátki mä-ímat isihí'lit ómati gi'lagíd ōs. Tamodshä'dshi talepó'lat omídatitäs istúngun inlopä'idshitad gi'lágit ōs. Squire Oglethorpe adshákkahid míkko 'lákon i'l'híχtchit, oponáyat i'límpoχit iyimunáhin, pohágidut akasamágid ómĕka.

tomahawk ; but the Palachucholas got it by persuasion, and buried it under their beds. The Palachucholas likewise gave them white feathers, and asked to have a chief in common. Since then they have always lived together.

Some settled on one side of the river, some on the other. Those on one side are called Cussetaws, those on the other Cowetas ; yet they are one people, and the principal towns of the Upper and Lower Creeks. Nevertheless, as the Cussetaws first saw the red smoke and the red fire, and make bloody towns, they cannot yet leave their red hearts, which are, however, white on one side and red on the other. They now know that the white path was the best for them : for, although Tomochichi was a stranger, they see he has done them good ; because he went to see the great King with Esquire Oglethorpe, and heard his talk, and had related it to them, and they had listened to it, and believed it.

THE HITCHITI TEXT.

YÁTI MASKOKÁ'LI HUNAKNOSÁ'LOKTAHÚNKA INNAKANÁHIGUT ÚMMIS.

Náki Tchikílli Maskoká'li há'htchi tukládshiga ímmigi ingaktahúnkat û'mmis. Sĕvä'na ókli lak'háχtchi imanólispi tchúk'bi=tchóbi 'lámin tchúk'bi kulapákin pokóli tutchínan tcha'hkípa=wäíkak fógun íngahin yátikut mamgúngas íngahin yánas'=hálbun undsha-uhóliktawāts; apû'ngi yámōsin:

Tchā'tchā'li íyaχni Safáni oklû'n lak'háχtchi ímanólispi tchok'bi=tchóbi 'lámin tchókbi kolapákin pokólî tutchínan tcháχgipa=weígak fógûn Tchikílli Maskóka'li há'htchi tukládshiga ímmigut aponiktahû'ngat û'mmis; Antítchi Káwiti ókli immiga=píktchi, íläidshi míki; O'sta Kasiχtá'li î'mmigi, Tamítcha hó'li mî'ki; Wáli Palaχtchuklá'li ího'li kapitáni, Puipá-idshi míki; Támhuidshi Yutchitá'li íf=miki; Mitikáyi Okoná'li ínho'li míki, Tuwidshä'dshi míki; Woyá'hni Tchiahá'li Okmulgá'li isiámika ímmiki; Stimalaχó-idshi Osotchá'li ímmiki; Hupí'li Sawoklá'li î'mmigî; Iwanági míki; Ta'hmókmi Yufantá'li ího'li kapitáni, tastĕnaká'li pokóli tutchínak ayámkan isáyak hapónik úngaktawāts.

Ní'htagi í'lin yáχnut ká'lali 'ladá ıun hawákĕlin Kasiχtá'li alok'laníshiaktawāts yák'ni idshún máhamîg labángosun i'líktawáts, mámiska yáχnut witíχkak hoboskún imanólîhîn; inhí'latīk sowaskádshik gá'lali 'ladákun í'liktawats. Mámiska aláχkut yalaskádshik i'liktahúnga nu'ládshîk í'liktawāts. Mámiska adshok=apiktcháχat yobalálun í'liktawāts; "mamikántun amakmówats" aχlití. Mámin û'mmi mámiska' yaχní hobóski imanóliktahunga imúngahin ibasnā'dshitik hántut há'lana 'ladákun a'ládshiktawāts.

Máhamik oki=tchóbi tchî'ktî okófki síliti talákan u'látchik mûn it=a-ulitkádshik fisáχkak ní'lăgi 'lámin nustchî'dshiktawāts. Háyatlin a'látchik oki=tchóbi gitī'stcha pítchiktch=úmiχtchut taláχan u'ládshik, mun í'lik 'lá'lusk imípibak, lakhátchi túklan ī''liktawats; mámiska okásut hamhopósin í'lĭgi immámitihin. Yá uki=tchóbi pítchiktch=ómika íkabî ‘latákun a‘ládshikan túnuχgaχtch=ungáχtchun inhákĕlik handú'n úngahōs ákĕlik hitchígûn ibasnā'dshik una‘ládshiktawāts. Intchiwátki útski gitistchû'n hídshaktawāts mámin ‘lani=tcheíhi tunuˌkáˌtchún, mámin ‘lani=tcheíhi ipákĕnun húpanaχtch=úngaχtchun inhaχlíktawāts. Náχot û'mmîga atá‘ligûn ákĕlik yátun untakás‘líktawāts; mámigan î'ti tchóbaχtchut ámbi ‘látaχun alafángumîgat hupánî'htch=ungómihin hídshaχtawāts. Yá ‘lani=tcheíhi ‘lani=tcheíhi lāpgun ímmigun kádshik hodshífaktawāts. Yámiska tunúχkaχtchi imúngawats, mámin yáti imma‘laslídshigut û'mmewāts.

Yálun yáti ógli má‘läχki tutchínan atabáksiktawāts. ‘Lani=tcheíhi hayokaháχtchi hídshak fógot î'ti isiχsihómid isiaúlidshiktawāts; mámik mûn ayiktchúska nanumí'htchuk sonábaka mûn atá‘laktawats, mámik nági=adshû'ngun atá‘laktawāts.

Hás=‘lanaχtchún úndiχtchut íti hátgut imílakma nanumídshitiktawāts. Wahálun û'ndiχtchut íti holätlút ílaktawāts; magá nanumídshitiktawāts. Ka‘lalíχtchûn úntiχtchut íti lō'dshut ílaktawāts; máka nanumídshitiktawāts. Sanatskí honi‘lún úntigat íti gitistchukmá laknû't ummiktawā'ts. Yán íti ishiaulídshihûngat itumpiliktahómid mûn yámiska î‘lídshik úmmes; mā'min máka hopā'naska í‘liχt úmmewats. Lani=tchäíhun pokábut unadsálik û'mmigat tchúnus'=hi‘lalátik hant úngaχtchut úmmîgan, nanumidshókan tchúnus'=hi‘lawats î'ngaska yáti aitíktawats. Mahámin immápun yátudshi ikî aitusíχtchun ísik isayatáblik yátudshi ilihúdshiktawāts. Mamí häi'htchik ma pokábi ísik hó‘li a‘ládshika isiaúlidshi'ht úmmiwāts. Átasi omíχtchut ómiktawats, yámiska isiaúlidshis ma-umíχtchut úmmiktáwats ahi malálut ómiwats.

Yán ayiktchút má‘läiχki sî'tagik inhítchkaktawāts hopának nanumidshigugá onálihin atá‘laktawats; íntchiwatki, pasóhin; satúklaka, huyanídshōn, áksi kitíshtchi; istutchináχat, sawatskō'n; issitágigat, aktchomodshóhin. I-a náki yámika pasún sowátchkon istúklaχa inniχtakúnlan î‘lik fógi isilafistaíli'htchût ómiwats. Ni'htagi mámî íntchangin í‘lik fógit nágut índshiwatki háyak û'mmiga mun wäili'htchut û'mmiwats. Yá náki yámika inhitchă'kaktahunga a'líaka hută'guska itamo'látchiwāts mámik fógi lámu'lun it=a-ulitkádshik, hunakní awiládshitik ní'htagi tsaχkípaska ipágiska kolapágiska ó'lahin alokúndi'ht ómiwāts; mámitīga ya ayiktchí inhitská'htchi isiaúlidshika inhampadshiwátis; mámihin hutăgāk tcha'htchû'nût ya-ulídshitigus.

Mámiga fóχun hántut naχnosót úmmik "nákoska yá'hmitis" í'ngan ya-ulídsoχ sonábahos itikádshik isiaúlidshik; "mámut û'mmitîs" itikádshik ógli sitágiti, "pokábi sitákin tchipi'hlí'htchik lokfún iskitistchádshotis; láknût û'mmikma nohádshokan gitistchá'htchut úmmitî" itikádshiktawāts. "Mahá-i'hmik ho'lún a'ládshotis; mámin ókli nánumigat bí'hkun pûχábi tchipi'hlitchígaχa íhu'li yōs'=hálbun illumpihálik lubulídshin ummigá-i mût náχnos=apiktchaχat ummiláχas" itikádshiktawāts.

Lă'pkut mamí'htchīgi ágelîg úmmikma, Kasiχtá'lo=χánut ímpogabi lobolídshiktawāts, mámik hanta=fóχun tchigaknádshik ómîti, hítchgatīn ómmiktawāts. Mámiti mûd ókli naknosaχáyus ókli lápkut ákliχtchut úmmiktawāts. Tchigasá'lut yóbali lobolídshiktawāts, mámihin Alibáma'lohin; mámiska Abíχka'lut hítu'lpi ayosíχtchun o'ládshiktawats.

Mámik fógi fósî tchóba'htchut, hólatlût, hádshi bádskiχtchut, hadshitúlami isínpatkut, ní'htak lápkun ílak, yátun ilístchik imanolí'htchut ómmiktawāts. Tă'g=ábun ómig fósî ilá'htchi itunáyăkan inhadshalídshiktawāts. Fósi ī'lak ī'sik sa'liyáhōmid atchíban ishialágak yehóndshiktawats. Náχuska hitchlídshiska ī'liwats ák'lik nanumidshitíhin a'líyaktawats; adshíbahin tchî'si kitistchút alok'laníyahin, ma fósut i'lkówats áχliktawāts. Ma tchî'si itimapusnídshik í'lkî nanumidshókat imillidshohós ák'lik isiaúlidshiktawāts; ma fósi íftchi=kutúkbûn 'láki ayámkûn i'lî'tchiχtchut ómmiktawāts. Tchísût íftchi=kutúkbi áksun kalífkak inkúslihin nánōmik ilimásatăi sonában ómihin ilihódshiktawāts. Ma fósi fósi î'mmigûn gádshiχtchut hudshífaktawāts. Hadshitúlam' aká mî'ki tchóbut ómmîs ák'lut ómmiwats, mámik ihádshi hu'lúska a'ládshiwats; mámik itihi'lkíkuska ák'lik yá-ulidshiga mûn isiaúlidshiχtchut ómmiwāts. Kitístchăχăt ho'lóhin hát kakat hi'lkígut ómmiwats. Inhu'lóska alokúntilāχā í'liwats mámin ómik=fógi fós=ihíski hátkun i'lídshik idshû'n hatlídshik hadshitulámi úngaχtchut úngak alokúntin ûmmigáyi, ilíχtchi'hlati'htchut úmmiwāts.

Yá í-obalun i'láhunka hóndshig a'ládshik híni hátkut talákan o'ládshiktawāts. Pahóska nak=lápkut hátkoktawāts; mámiti yátut ya-ulídshi=hí'lut úmmihin hídsaχtawats. Híni tafámaskadshig imawílosihin nustchídshiktawāts. Ma haihimí'htchi i-óbali yalaskā'dshig, hî'ni nánomût ummís=aχá yā't nánomût yaúlidshik úmmis=aχá atá'lak, múska alítak ya-ulitchúχantun hí'luska ómikûs áχliktawats. Mun alítak a'ládshik há'htchi Kolósi gádshikun u'ládshiktawats; Kolósi kádshiga táli ayógaχtchut ómmîg pafáktsiχtchût ómmiti mûn hudshífak úngaktawats.

'Lanisyádshik hási='lána 'latáχun a'ládshik óklun Kósi i'hkíkut í'lihin u'ládshiktawāts. Yán í'lin lak'háχtchi sítaki ó'laktawats. Kósa'lut únkakat "yát=imput áyak yátun pumanolíχtchut ommi'htchámas" íngaktawāts, "táli ókbun afóksak úmha'hmis" íngahin.

KasiχtáClut úngakat: "ilídshiki ak'lígalākas" kádshiktawāts. Yaχnún ka-élik hayoχkún ómig ō'dshagi hálbun tá'lak abōdulídshik ahoposkún û'nsalik yátipi adshakúntiti sunában ómmîg. Mamí häí'htchik una'ládshik sá-ukun imókĕlûn imúmpi'lpahin. Yát=ipi witíχka'h=hí'lut alok'linígak ahopuskí tcho'h'lólik asówahin; mámik=fókun yáti 'lámosik inlikántun ahí'lowats, lápk=apiktcháχat māmitíwats, ák'lig, yák'ni ká-igi awiládshin ik=imilódshûn bi'hkún î'mpi'lban, un'linígak yák'ni=kä'-igun una'lálihin. ō'dshak=hálbi tá'la'htchi i'lídshihungat unalobídshik tchû'yi ayokáhaχtchun isbatásbig ilídshiktawāts. Ifón=aχá yámiska i'lídshi imúngawats; apáluakat gitistchóhin, apáluwut hólatlud û'mmiwāts.

Yát=ipi ni'htági kolapágik fógun ílak yáti ilístchiχtchud úmmiktawāts. Mámiti ilídshik fógi malálun í'lin ní'htagi kolapáki ó'laktawāts. Ma isa'léχkun ho'lúsga a'ládshāhik imitunábaga impatíhin ní'htagi ípāki ó'lan iskolapákikan a'ladshíχtchut úmmiwats; ifónun ishiaúlīdshik û'mmiga nági inhitskahí'lut û'mmiwats.

Ma'hmáhunga lak'háχtchi sítaki ó'lan Kō'sa'li húndshik a'látchika oki⸗tchóbi Nófāpi kádshigun u'ládshiktawāts; yamigáyi Kalósi há'htchun kahudshíχtchut úmmis. Mûn í'lin lak'háχtchi túk'la ó'laktawats; máınin ashpúshka aitīdshití nākosúska ínka-ilik ímpak, 'la'lúska ímpak, íftchi⸗kutúkbuska û'mik, ín'lăgi pusā'fi inótuska tchunu'lúska abánaslik imfaskí'htchi ómik, iskaláfkoga o'lánun tukaílik úmmiktawāts.

Yáli í'lihunga hún'htchik a'látchika Wátuli⸗úngi há'htchun o'ládshiktawāts, únga kádšhiga mûn wátûlût ohí'laχtchut û'mmiti úngaktawāts. Mûn ní'lagi 'lámin nustchídshiktawāts. Ma haíhimíχtchi a'ládshiga oki⸗tchóbi una'lálī'htchun o'ládshik U-i⸗túmkun hodshífaktawats. I'lín ní'htagi oki⸗tchóbi Afusafíska kádshigun os'látchiktawats.

I'lín ní'htagi 'lanisyádshik, a'ládshigat 'lani⸗dsheíhun o'ládshigan, yátut í'lin u'látchik híni hátgi ummí'htchi yauli'htchikat úmmiwats ákliktawāts. Mámiti 'lági hátgun û'mik istchanápliktawāts, yáti hí'lut û'mmika atá'likun áklik. Mámikma ma yáti 'lági hátgi istchanáplika kitistchádshik alokyalalíndshiktawāts. Mámen mígun hidshahúdshikan, "hí'latik úmmis," íngaktawats, "'lági alokyalákakat hátgut ûmmahúnga, una'ládshik impigúska hupúski inhitslidshatskaktahúnkma; gitistchúti unati'lya꜊tchátchkis" kátchiktawats. Mámi hantámiska yáti nánomut ómmika hidshígun áklik una'ládshi yámiktawats; mámikan tchikasípahin tchíki tánkōhin hídshaktawats; mámikan a'látchiga hídshkak úmmekat oki⸗tchóbun kutānisyātchohin hídshaktawats; mámikat os'lanisyádshikan hidshatíti oki⸗tchóbun kutānisyádshik ómmik, alok'lanisyádshitikus áχliktawāts.

Mûn 'lani⸗tchäíhut Móterell í'hkígut tchokólik û'mmigat tamamápk' ungá'htchut únga'ht úmmiwats; mûn ma yáti í'lik ummitúgas ak'hóliχtchut úmmiwāts. Hu'lúska a'látchika hantû'ntuska inhag'líχtchut úmmiwats.

Ma óki⸗tchóbun apatalídshik a'ládshik óki una'lalíχtchun os'látchigan táli hóti'htchut í'lihin íftchi⸗kutúkbut unsalkádshin hídshak, "híni hátki úmmi'htchi yá-uli'htchigat yáulidshik û''hmisis" áχliktawats.

Hántun a'ládshik yá-ulidshiga túklak bí'hkun yá-ukan a'ládshiχtchut úmmiktawāts. Yá bíχki yá-ukaχat 'lani⸗dshäíhun un'lanishíakan ok'lóhin hídshaktawāts. 'Lági hátkun istchanápligan 'lági gitistchún alokistchanápliktawāts. Mámin Kasiχtá'li witiχwógak itíbik ók'lûn imísohin, úmmik fógi tchikû'n situnabikaláχas ákliktawāts. Tálun okiˑtchóbi kábi'lbak 'lanóχ sunában û'mig ókli imísikan (yáti i-ósi padshakpáfut úmmiktawats) lápkun oɩsídshihin; túklosik aláɩkiktawats. Asówak isa'ládshikan í'fi hátkut áyan atábaksik ilídshiktawāts. Túkla palákakan asówak sa'lā-dshik múngak 'lúk híni hátki talákakan isu'ládshikan okló-hin ítut pafáɩsin hídshak, mû't yáti hopoyigaɩtchámat úmmiwats, ákliktawāts. Yán Palaɩtchuklá'li í'lik úmmîhin Tamodshá-edshi mûn abitiliɩtchut hadshálik úmmis.

Kasiɩtá'li pidshíktchi piháligun imalósta'htchut imúngak û'mmikma Palaɩtchulá'lut hi'lkíki isa'lä'ɩkun ă'sun iwäílik: "púdshunusbi hát'hugut úmmis, mámin tchíɩnak hatkaló-χatis, mámik átasi pidshiktchˑukúliˑka találik idshíkni isa-tá'lkalaɩa hatlídshitis," kádshiktawats. Mámiɩ hantámiska atasúntun imálostud û'mmigma, Palaχtchuklá'lut is'húndshi-dshitik imísik îmáyi í-aɩnun hópik; fos'ˑhátgi hisk'ˑaɩá imígak "pû'mmigi 'lámositis" kádshiktawats. Ma haí'hmik-tahunga unábaka itúmpiɩkak í'liktchut û'mmiwats.

Álaɩkut okiˑtchóbi apáluan í'lihin, álaɩkut apáluan i'liχt úmmiwats: apaluá'htchi í'ligan Kasi'htá'lun kádshik; apa-luá'htchi í'ligan Kawitá'lun kahodshíɩtchut úmmigma, ókli 'lámosiɩtchut úmmiwats, mámik Há'htchapaluá'li Há'htcha-tá'li yámiga ókli isíhotosut úmmiwāts. Mámi hantámiska Kasiɩtá'luˑkánut û'tski gitístchˑaka hídshak íti kitístchakˑáka hi-itchaktáɩtchut û'mmik ók'li pitchiktchúska ummiktá'h-tchuti tchû'nusbi kitístchˑaka húndshitik úmmiska, apáluak hatgóhin apáluakat kitístchut úmmiwats.

Mámis kayámiga híni hatgaˑɩántut isinhí'la'htchut úm-miga atá'laɩˑhí'lut úmmiwats. Tamidshä'-idshi yáti ata'l-katíɩtchut úmmigma, nági imása'htchut úmmin atá'lowats; ógil'lop adshaka'líak mígi tchóbi o'lhídshak apû'ngi í'nhak'-lik, ó'lilak anáhin inhaklik akásamiti.

EXPLANATORY AND CRITICAL REMARKS

— TO —

TCHIKILLI'S KASI'HTA LEGEND.

Tchikilli, the head of the Maskoki confederacy, styled here and elsewhere "Emperor of the Upper and Lower Creeks," is but little known. A letter written or signed by him in March 1734, announcing his safe arrival in Savannah (cf. i. p. 236), has been preserved; also numerous letters of English officers, in which he figures prominently.* In the sentences following the legend he states that he originates from the *oldest town*, and was elected to the head-chieftaincy after "Emperor" Bream's death; it is therefore highly probable that Kasi'hta town was his home. Although he represented all the other tribes of the Upper and Lower Creeks just as well as his own, he chose to relate to the colonists the legendary history of *his* town, in preference to the legends referring to other Creek towns.

The name-list of the chiefs standing at the head of the legend contains but Lower Creeks, Tchikílli, as the head-chief, being the only representative of the Upper Towns. It is possible, however, that the "thirty other warriors" included Upper Creeks. The names are written so carelessly that doubts arise about the real pronunciation of some among them, as Eliche, Euchitaws, Eufantees. "Euchitaws" is meant for the Hitchiti, not for the Yuchi tribe, which in 1735 had but a few representatives on and around Chatahuchi river. The "Eufantees" are misspelt for Yufalis, Yufála being an important community on the Lower Chatahuchi. Many of the chiefs are mentioned by their war-titles, not by their real names, *e.g.* the *dog king* of the Euchitaws; but they came to Savannah in a civil capacity, and the majority of the chiefs and headmen, whose names are given, were the civil and not the military heads of their respective towns.

* D. G. Brinton, the Chahta-Musk. Legend, p. 5.

The Kasi'hta chief is, in Chief Chicote's opinion, called O'sta, or *four*, because he was then considered as representing the four leading towns of the confederacy: Kawíta, Kasí*z*ta, Ábi*z*ka, Tukabá*z*tchi.

"The Earth opened in the West, where its mouth is." The issuing of the Kasi'hta people from the ground should not be viewed as a birth-act of the Earth, the common mother of all mankind. It is the ascent of man from a lower into the upper world. Of these worlds, or successive places of human existence there are four, five, or even more, in the different mythologic systems of the American Indians, the one mentioned here being the last or present world, with all its sorrows and joys. Some old Creeks are still acquainted with a superstition parallel to this: When their people move west again, they will disappear in a place called "the navel of the Earth." This is the name given by the Chicasa to a certain mound in their old seats; they believed that this mound, which was probably of a peculiar shape, was the navel and only visible part of a giant stretched out under the earth's surface—the giant being, of course, the Earth itself personified. Many primitive nations believe that the shifting of a giant's underground position is the cause of earthquakes.

To compare this "mouth of the Earth" with the numerous places which the Greeks and Romans regarded as the entrances to the *inferi* or nether regions (caves, lakes, ponds, etc.), or to the orifice through which the sun reaches its nocturnal abode every evening, would be wrong. The Nani Waya myth of the Cha'hta gives us the correct explanation of the passage.

"The Earth became angry and ate up their children." The sense of this passage is rather mysterious, and it seems strange that the offspring of those who had just emerged from mother Earth into a superior world should at once be destroyed by the Earth itself. This calamity has to be placed in connection with the low or infectious springs of water mentioned below. What induces me to explain the term *eating up* by the ravages as the consequence of epidemics, of *typhus* or *malarial fevers*, is the following: the Klamath Indians of Southwestern Oregon believe that the Earth is incensed at them, and threatens them with death, when they see fogs creeping along the ground, not more than a man's height from the earth, which cause malarial fevers. The females have made a song on this, which runs as follows:

Mbúshant käíla t'hämō'la,
shitchákta nä'ts käíla,
shikuapkúka nä'ts käíla.

Or in English:

In the morning the Earth was clad in mist;
Incensed at us was the Earth,
For to kill us wanted the Earth.

The Kalapúya Indians personify malarial fogs arising from lakes, prairies, etc., in the shape of Amhúluk, a terrible, irresistible monster, whose home is in the depths of a mountain lake near their homes, in Northwestern Oregon. — A ridge of mountains northwest of San Buenaventura, near the coast of California, is called Alu-úku, or "earth that will eat up people."

Whenever whole tribes or nations migrate to distant countries with imperfect means of locomotion, epidemics or a high death-rate are often observed to curtail their number, especially that of the children. Even changes of climate are fruitful in producing distemper during migrations.

It is curious to notice, that, like our legend, the Iliad also begins with the narrative of a plague sent to the camp of the Achæans by the offended Apollon (Iliad i. 43–53), which lasted nine days and destroyed many of their warriors and beasts of draft; cf. v. 53: *ἐννῆμαρ μὲν ἀνὰ στρατὸν ᾤχετο κῆλα θεοῖο.* Apollon is the personification of the sun-rays; when in the height of summer they powerfully strike stagnant pools, or decaying matter, hey develop epidemic fevers, and the darts (*κῆλα*) of the sun-god become the missiles or messengers of death.

"THE CHILDREN OF THOSE WHO RETURNED EASTWARD WERE ALSO EATEN UP BY THE EARTH." To this passage the German original adds a note intended for *localizing* this occurrence: "According to the French Indians, there is a large city where a blue-lipped people live, of whom they (the Creeks) have often heard it said, that, if anybody tries to kill them, he becomes insane." The French Indians were the Cha'hta and the tribes on the Lower

Mississippi; and many primitive nations, also Indians, believe that the killing of certain kinds of game will bring insanity upon those who kill them. Dr. Brinton has found a passage referring to Blue-lips in "A State of the Province of Georgia," London, 1741, (in P. Force's Coll.), p. 1: "The Blew-mouths and other Indians live toward the South Sea." To this I add a passage from "Views of Louisiana," by H. M. Brackenridge (1814), p. 86: "Blue Mud and Longhair'd Indians; numbers unknown, supposed to reside somewhere on the heads of the Columbia River"; and another from a volume of "American State Papers" (Land Affairs), in a document, "A State of the Province of Georgia," dated Savannah, Nov. 10, 1740: "This province (of Georgia) was once part of South Carolina, but the eastern and southern parts of it inhabited by the Creek Indians, the northern by the Cherokees and Chickasaws, the western by the Choctaws; the Blew-mouths and other Indian nations to the South Sea." If any inference can be drawn from the term *Blue-mouths*, we may recall the fact that the Comanches, Kayowēs, Wichitas, Pánis, and all Texan tribes painted their faces in all sorts of colors, and often in the most repulsive manner. By the "South Sea" the Pacific Ocean is meant, and all of the above tribes roamed on the plains west of the Mississippi river.

An instructive parallel to this is the legend mentioned by B. S. Barton, "New Views on the Origin of Tribes or Nations of America," Philad., 1798, p. xliv.: "The Cheerake tell us that when they first arrived in the country which they inhabit, they found it possessed by certain *moon-eyed people*, who could not see in day-time; these wretches they expelled."

Bénard de la Harpe, who at the head of troops explored, in 1719, the countries along Red river, also speaks of a similar-looking people; see Margry, Découv. vi. 292.

"THEY HEARD A NOISE AS OF THUNDER; .... AND ON THE MOUNTAIN WAS A SOUND AS OF SINGING." Noises in nature are by primitive man invariably attributed to some genius or spirit. Winds have been deified and personified in all ages and climates, as in Zephyros, Boreas, Wuotan, Hurakan, Kabibonokka, etc.; also the thunder and the echo. Wherever our legend speaks of noises being made by fire, etc., these noises are uncommon, unaccountable, though distinctly audible, and generally of short or limited duration; therefore they must be of supernatural origin, and a spirit is thought to be their author; he has to be "interviewed" about the matter, and, if possible, propitiated. The ancients held that Fauns, Satyrs and Pan produced noises in the woods, or in the atmosphere, and that they had to be propitiated by sacrifice. In this country several rivers and large springs of Northern Florida are believed to produce noises at night; they are hence regarded with superstitious awe by a part of the population. The howling storms at the entrance of Yaquina Bay, Oregon, were thought by the Indians of that coast to be the plaintive voice of the spirits which had fled from the corpses of Indians disposed of in canoes or rafts and driven out to sea. Manitoba is originally the name of an island in a lake of the Manitoba country, near which the noise of a *manitu* or spirit was frequently heard; the name being an abbreviation of manito=wapan, which is interpreted by *divine sound*, supernatural water-passage.

In the East, the Machemoodus or Moodus noises have attracted the notice of the public and writers have discussed their origin. Machemoodus is East Haddam, Connecticut, particularly the northwestern part of the town, near "Mount Tom"; abbreviated into Moodus, it designates a branch of Salmon river, and a manufacturing village. Matche=mâdosé means, ' there is a bad noise"; with locative affix, Matche=mâdoset, "at the place of bad noises."*

The great-grandfather of the celebrated Sac chief Black Hawk, Nanámaki or *Thunder*, was born in the vicinity of Montreal, where the Great Spirit is said to have placed the Sac Indians first. About the year 1833 Black Hawk, when giving an account of his eventful life, mentioned the following experience of Nanámaki:

The Great Spirit announced to him, that, after the lapse of four years, he would meet a white man, who would be a father to him. To prepare for his appearance, Nanámaki blackened his face, and ate but once a day, at sunset, during three years, a practice which caused him to dream continually at night. With his two brothers he then went east for five days;

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* J. H. Trumbull, "Indian Names in Conneeticut," p. 18 (1881), who quotes concerning the " M. noises," Trumbull's Hist. of Conn. ii. 91, 92, and Barber's Hist. Collect. 525-527.

then he stopped and sent them out *to listen for a noise*, with the injunction, that, whenever they heard a noise, they should fasten some grass to the end of a pole, set it up erect pointing in the direction of the sound, and then return to him. Early next morning they reported having heard unusual noises, and set up the pole in consequence. Nanámaki found the white man he was in search of; he had just arrived from France and pitched his tent. He said he was the son of the King of France; the Great Spirit had sent him to this "nation of people" to be their father; he gave him a medal and directions for the government of his people; guns, powder, lead, spears and lances; his followers he presented with cooking utensils and other presents; and then returned to France, to come back again next spring.*

Le Page du Pratz, "Hist. de la Louisiane," mentions a hollow and distinctly audible noise heard for eight days in March 1722, from the Gulf of Mexico up to Illinois, which proved to be the prelude of a terrific hurricane.†

The Tonkawéya Indians of Texas, whom I visited in 1884, have the following superstitious belief:

When an unusual noise is heard at some spot, as from throwing stones over a steep declivity, or from crying, dancing, these Indians avoid visits to that place, especially at night, as they suppose them haunted by the spirits of the living or the dead. The noise most commonly made by the spirits of the dead is whistling and throwing stones, especially during strong gusts of wind. When the fire-wood begins to sizzle and emit steam from being moist, they suppose a ghost manifests itself and tries to escape; so they cover the wood with ashes, to confine it within and to stop the whistling.

Qu'appelle river, a tributary of Assiniboine river — in Cree, Katapaywie Sipi — is called thus because of unaccountable noises which resemble the voice of a person calling another. Cf. Hind, "Narrative," i. 370; J. J. Egli, "Nomina Geogr." i. 466.

"AT FIRST THEY PERCEIVED," etc. This passage is not rendered verbatim in Stidham's Creek translation. The Creek turns the sentence as follows:

And they saw a red smoke as if issuing from a mountain; and they heard on the top of that mountain [something] like singing.

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* "Life of Makataimeshekiakiak, or Black Hawk," Boston, 1834, pp. 13-16.

† English edition, p. 33. Cf. H. Hale, "Ethnography of Wilkes' Expedition" (1846), p. 55.

"FROM THE EAST A WHITE FIRE CAME TO THEM," etc. This passage on the fires of four colors is understood to be of importance for the study of color symbolism, because the points of the compass assigned to each of the variously colored fires are supposed to be connected with the color-shades of the fires. But is there any connection or not? The fires are mentioned here evidently as belonging to ceremonial rites, and the fact that they were singing and could be mingled with other fires shows that their color was the result of the fuel thrown into them. Certain plants or trees containing more moisture than others will sing or sizzle in a manner different from others, and will produce a denser, duskier smoke than those whose normal condition approaches that of exsiccation. The fire which the Kasi'hta saw first on the mountain was red, and its smoke was red also; this they mingled with their present ceremonial fire, which is red and yellow. This is the natural color of fire made with dry wood. A black fire is a thing never heard of; "black" can point only to a dense black smoke developed from the herbs thrown into the fire. When the conjurer first lit the *new sacred fire* in the annual busk, he threw ears of corn and medicinal herbs into it (cf. i. p. 179, 181), this being referred to by our passage, "and this is the fire they use to-day." The red smoke and the red fire, as first seen by the Kasi'ta, are referred to again at the end of the legend. The fire they had seen upon the mountain and saved was a red fire, for its smoke was red, and, when they had met the three other nations, they gave it a yellow admixture: "a fire came from the North, which was red and yellow."

The ancient Creeks had a fanciful way of selecting their medicinal plants according to the direction in which their stems or roots were running; thus they, for certain purposes, selected roots running from North to South, or others that ran from West to East. Some plants could only be gathered in four nights of the year, which were fixed by certain rules prescribed by the conjurers; others had to be collected in certain four nights of four different lunations, or in four lunations each belonging to different years. Rules like these existed in infinite numbers, and were increased or modified at will by the inventiveness of the conjurers. The Kasí'ta legend brings the colored fires in immediate connection with the four herbs which were of a medicinal or sacrificial character: "*here they also found four herbs or roots, which* SANG *and disclosed their virtues.*" This circumstance fully entitles us to explain the above colors of the fires by conjurers' rules similar to the ones mentioned above, in which the "sacred" number *four* plays a prominent part.

But, before arriving at a decision, let us quote some of the more prominent Indian myths and mythic ideas which distinctly associate colors with the points of the horizon.

The relation of the points of the horizon to certain colors is clearly defined in the *Návajo* creation-myth as published by Dr. W. Matthews.* The following extracts embody the most important features of this instructive myth:

In the second world, to which the primitive people had ascended from the first, there was *light*: in the east there was a great darkness; it was not a cloud, but it was like a cloud. In the south there was a blue light, in the west a yellow light, and in the north a white light. At times the darkness would rise in the east until it overspread the whole sky and made the night. Then the darkness would sink down, the blue light would rise gradually in the south, the yellow light in the west, and the white light in the north, until they met in the zenith and made the day .... Now there dwelt beyond the earth, in its four corners, four other persons: one was he of the darkness, in the east; another was he of the blueness, in the south; another was he of the yellowness, of the west; and the last was he of the whiteness, of the north. And the five that dwelt in the center of the world (First Man, First Woman, Sun, Moon, and Cóyote) called these four into council, ... and they decided that the second world was too small for all to live upon in peace, and that they should ascend to the third world .... This they found to be a land bounded by four mountains; there was one mountain on the east like San Mateo, one on the south like etc.; and they found a great water at each of these four points. .... Then the Cóyote† stole two of the children of the ocean monster Ti-eholtsódi; but the monster took revenge by causing the waters that were in the east, the south, the west, and the north, to rise and flow over the land ...... Then the people ascended into the fourth world by inclosing themselves into the joints of a reed which grew miraculously fast. There they had still the darkness of the east, and the three great lights, as in the second world. On the north shore of a river, which intersected

* Rev. St. D. Peet's "American Antiquarian," Chicago, vol. v. 207–224, (July, 1883): "A part of the Návajo's Mythology." The Navájo Indians are of Tinné lineage, and occupy a reservation extending through parts of Northern New Mexico and Arizona.

† Cóyote, or the prairie-wolf, *Canis latrans*, is an Aztec term, "the burrower," which is used throughout the west of the United States.

the whole land from east to west, the people settled, while on the southern shore the animals (then in human shape) took their abode.

The ocean monster, in revenge for the abstraction of his cubs, caused the waters to rise again in the fourth world, compelling the inhabitants to a speedy removal. The badger delved a hole up to the fifth world, and the locust, climbing up through it, saw there four swans: a black swan in the east, a blue swan in the south, a yellow swan in the west, a white swan in the north The lake which they found there was speedily drained by the genius in the dark east, but its bottom remained soft and muddy. So they prayed to the four winds, the dark wind of the east, the blue wind of the south, the yellow wind of the west, and the white wind of the north. And a great gale arose and blew for four days, and on the fifth day the ground was so dry that they could walk out.

... It is from the west that the snow comes in the winter, the warm thawing breezes in the spring, and the soft rains in the summer to nourish the maize and the grass. Therefore, when the Návajos are in need they pray to Estsanaltehi, the goddess of the Sunset Land. First Man and First Woman were banished to the east, and swore undying hatred to the Návajo people; therefore all evils come from the east, small-pox and other diseases, war, and the white intruder.

The distinction between an upper and a lower world is still traceable in Iroquois myths,* and also forms the foundation of the Greek speculations embodied in such terms as the *empyreuma*, the *cycles and epicycles of the planets* crossing the crystalline skies, *the seven heavens* of the Orientals, and the Hebrew *rakiah*, translated in the Vulgata by *firmamentum* (Genesis i. 2), or "solid matter, solid ground."

The Northern Lights were (to the Iroquois) the indication of coming events. Were they white, frosty weather would ensue; if yellow, disease and pestilence; while red predicted war and bloodshed; and a mottled sky in the spring-time was ever the harbinger of a good corn season.†

To understand this passage fully, it must be remembered that the color-beams and rays of polar lights are to the Indians the spirits of the deceased (as are also the shooting stars, fire-balls, meteors and meteoric showers), and that the rapid changes which these multicolored lights are undergoing are called by them the *dance of the dead*. Now, to the spirits of the dead prophetic powers are ascribed among all nations, especially when they appear in dreams.

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* Elias Johnson, "Legends, etc., of the Iroquois," p. 40, 41.

† "Myths of the Iroquois," in Amer. Antiq. iv. 35.

The *Zuñi Indians* of New Mexico. who live but a short distance from the Návajo people, assign colors to each of the four points of the compass, and also to the upper land or region in the zenith, and to the lower region or nadir. According to Fr. H. Cushing's statements, their nomenclature is as follows:

North: pish lan kwin ta'h na, "the direction of the wind-driven places (the plains)"; same term used in their archaic or sacred dialect. There dwell the master-gods of all gods. The color is yellow.

West: sún ha kwin ta'h na; archaic, t'shiäli shi in kwin, "the house of waters"—harbors the younger brothers of the north gods. Color blue, the color of the ocean.

South: má k'aya kwin ta'h na, "the direction of the salt-water region"; archaic, ála ho in kwin, "the home of red shells"—the younger brothers of the west gods. Color red, the red shells meaning flowers.

East: té wan kwin ta'h na, "the direction of the rising day"; archaic, té lu in kwin, "the home of the beautiful day." Color white.

Upper regions: íya ma kwin ta'h na, "direction of above land"; archaic, iya ma in kwin, "home of the above." Many-colored.

Lower regions: mä'ni k'ia kwin ta'h na, "the direction of place below"; archaic, má ne la in kwin, "the home of the below." Color black. The genii of the lower regions are considered the younger brothers of the genii of all the five regions abovementioned.

The clouds of four colors, which appear to the youths of the *Ogláta* tribe, of the Dakotan family, in their initiation-dreams and visions, are white, red, blue, and yellow; they correspond to the four points of the horizon and to the winds blowing therefrom. They are described by Miss Alice C. Fletcher in the Reports of the Peabody Museum;* in the same collection she has given a sketch of "The religious ceremony of the four winds or quarters as observed by the Santee Sioux" (iii. pp. 289–295). This belief is general through all the Dakotan tribes (J. Laflèche).

Fr. Gemelli Careri states that the *Aztec* symbol of the south was a rabbit painted upon blue ground; that of the east, a reed upon red ground; that of the north, a lance with a head of stone (tecpatl) on yellow ground; that of the west, a cabin on green ground.† The four hundred men (the stars) whom Tezcatlipoca created continued to live in the third heaven..........and were of five colors: yellow, black, blue, white, and red (which means that they were distributed around the zenith and to each of the four

* Report of Peabody Museum of Archæology, vol. iii, p. 285, in the Notes (Cambridge, Mass., 1884).

† H. de Charencey, "Des couleurs considérées comme symboles des points de l'horizon," in Actes de la Soeiété Philologique, vi. No. 3 (Oct., 1876), pp. 163, 164.

cardinal points).† Quetzalcoatl's temple was divided into four apartments: one towards the east, yellow with gold; one toward the west, blue with turquoise and jade; one toward the south, white with pearls and shells; and one toward the north, red with bloodstones.‡ The four rain-gods or Bacabs of the *Maya* religion are called by Cogolludo "the gods of the winds." The south (hobnil, or "belly") was yellow, the promising color of ripe ears; the east was red, the north white, the west black.§ Among the *Tarascos*, the four attendant goddesses of the female deity Cueravaperi were personifications of the rains from the four cardinal points. At the sacred dances of the people these attendants were represented by four priests clad respectively in white, yellow, red, and black, to represent the four colors of the clouds.||

From a communication of Prof. Max Müller, Oxford, we gather that the ancient *Irish* had likewise assigned colors to the four cardinal points or to the winds; the east wind is represented as purple, the south as white, the north as black, the west as dun. (Whitley Stokes, "Anecdota Oxoniensia.") This is very like the distribution of colors among the four cardinal points which are found in the Veda. In the Khandogya-Upanishad the east is red (rohita), which is natural; the south is white (sukla); the west, dark (krishna, or *dark blue*); the north, very dark (paran krishna).*

We scarcely need to recall here to our readers the fact that specific colors are ascribed to each of the three great gods of the Hindu Trimurti, Brahma, Vishnu, and Siva; and also to the principal deities of the Egyptians.

In his publication, *Des couleurs considérées* etc., Count H. de Charencey has conscientiously gathered in tabular form all the various American color symbols known to him which refer to the four cardinal points; those of the Maya, Guatemaltecs, Creeks, and some Tinné tribes, with two systems of the Aztecs (p. 178). They differ among each other almost in every particular, and also from those just quoted from Dr. Brinton.

† Brinton "Amer. Hero-Myths," pp. 77, 78.
‡ Brinton, "Hero-Myths," p. 96, from Sahagun, ix. ch. 29.
§ Brinton, "Hero-Myths," pp. 152, 153; cf. de Landa, "Relacion," pp. 208, 211.
|| Brinton, "Hero-Myths," p. 229.
* The letter is published in the London "Academy," Nov. 3, 1883, and reprinted in "Am. Antiquarian," vi. (1884), p. 115. Cf. Dr. Brinton. "Folk-Lore Journal," i. p. 2¡6.

In many of the myths quoted above there is a relation distinctly traceable between the colors and the clouds appearing in the parts of the horizon referred to. Now clouds are indicators of the winds and weather, and upon the changes of the weather all human and animal life depends. We may therefore understand how colors could become not only cloud and weather symbols, but also symbols of the deities representing the agencies controling the state of the weather, and that they could finally stand for these deities themselves. These relations of the colors to the weather necessarily differ according to the climate of each country; hence the lack of agreement between the above-mentioned colors of the various nations.

We have here another evidence of the fact that specific religious ideas (not the religions themselves) are produced by climate.

COLOR SYMBOLISM.

A few remarks on a topic closely related to the one just treated of may find its place here on account of its wide adoption among Indian tribes; we mean the symbolic use of colors.

Among rude and civilized nations alike, certain colors which possess relations easily thought of to objects of common use, or known to all, were at all times used as signs or symbols for these. Symbols like these figure in garments and beads, on devices and banners, on architectural ornaments, in idols, in memorial beads and quipos, in heraldry and signals, and often designate things of an abstract nature. The bright colors form a contrast to the dull color-shade of the objects which commonly surround us and they strike the eye in a pleasant manner; color symbolism hence became a popular custom throughout the world. Indians who use gesture language have also gesture signs for colors. Color symbolism may find here a few illustrations taken from American nations only.

The string-records of the ancient Peruvians consisted of cords having one, two or several colors, and were called *quipo* or knots. Yellow meant gold; white, silver and peace; red, war and warriors, troops; green, the different cereals. Quipos were found among the Central Americans, Orinoco and Chili Indians; a tribe of the latter, the Araucos, had brought their laws, *admopu*, into this shape of memorial help. Among the Tlascaltecs they were called *nepohualtzitzin*. Instead of using strings, the Ecuadorrians around Quito resorted to pebbles of different colors, which they arrayed upon boards; nowadays, the Arizona Indians of the Tinné and of the Yuma race use sand or wood of disparate shades of color to construct their magic circles, each of these shades having a symbolic meaning. In the wampum belts of the Iroquois, Huron and Algonkin tribes the white beads indicated benevolence, peaceful relations, or the conclusion of a treaty; red meant war; black, death, danger, or warning; while by the brown and dark purple beads, the most precious of all, things of vital importance were indicated.*

The Aztec pictographs, as represented in Lord Kingsborough's plates, are adorned with significative colors, and cannot be fully understood without a study of the color symbolism embodied in them.

A curious instance of color selection, if not of color symbolism, was noticed in 1882 by Dr. W. C. Hoffman among the Arikari Indians at Fort Berthold, Dakota Territory. These natives plant maize, the ears of which show different colors, as amber, dark red (called *black* by them), dark yellow, light red, while some ears look spotted because the grains are of different colors. Maize of each of these colors is planted by *specific families*, and, if in their fields ears are found that are not of their own color, they deliver them to one of the families owning that peculiar color. More on the significance of certain colors, see in Fourth Report of Bureau of Ethnology, pp. 53-57.

Among American tribes, the color-shades most frequently appearing in a symbolic signification are *blue*, *white*, *red*. We give the following instructive examples, chiefly from Maskoki folklore:

Blue.—The bones of the istipápa or "man-eater" were, in the opinion of the Creeks, red on one side and blue on the other; and these were also the colors of their body-paint on many occasions.‡ Blue was the color of the deep hole in which the snake yielding the tchíto yábi was living; the large-sized bird preying upon the Creek people in the legend was of blue color. The Cheroki had a gens called the *blue* gens, anisahókni. To the Omaha, Ponka and Sioux Indians blue is the symbolic color for the winds, the moon, the water, the west (cf. Zuñi, p. 41), the

* Cf. the passage of Milfort on "Creek Memorial Beads," in Migr. Legend, vol. i. 187.
† Urlsperger, Nachricht, i. 860.

thunder, and sometimes the lightning).* Compare also the name of the Blue-Mouths and what is said of these legendary people p. 35.

White is among American Indians,† just as it is with us, obviously, symbolic for peace, good-will, friendship, innocence, and purity. Among the Dakota it points to consecration when seen upon the plumage of birds. Among the Maskoki the white feathers of the eagle meant peace and friendship: at the installation of Milfort as the nation's Great Warrior, one of the mikalgi presented him with a white tobacco-pouch made of a swan's skin, its white color indicating peace and friendship of the Creeks with the French nation.‡ The white path and the red path are often referred to in the legend; the white arrows are placed in opposition to the arrows painted red; spittle is white, and therefore a sign of peace also. White sand was sprinkled over the area of the square on the first festive day of the busk. White ashes were rubbed over the body as part of a religious ceremony, and the uses to which other white objects were applied are to be found vol. i. 181. For certain ceremonial dances of the Southern Indians, the body-paint in use was white; it was called kúpshesh by the Shetimasha. The official title of the Tatars and Tunguses for the czar of Russia and other rulers, is the *white czar*, viz., "the good, peaceful ruler."

Red meant contest and *war*, and is clearly symbolized in the *red* or kipáya towns of the Maskoki proper. Red was suggested, as the Cha'hta governor, Allen Wright, explains it, by the red flush of the *angry* warrior's face, which is conspicuous even when the Indian's skin is of a very dark complexion. Red as a war-emblem is frequently met with in our legend and in traditions of Southern tribes. The pillars sustaining the cabin-roofs of the red towns were painted alternately red and white; the bones of the "man-eater" were red on one side and blue on the other; the scalp-pole (itu tcháti, *red pole*), which could be raised by two tribes only, was painted red, and gave origin to the terms "Red-stickers," "Red-stick war"; cf. i. 77. The tribal name of the Huma contains this epithet; the gate and the interior of the Taensa temple of worship were painted red, when seen in 1682; cf. Margry, Découvertes, i. 567. The body-paint in use for certain dances was a *red* one. The pillar dividing the territory of the Huma from that of the Bayogoula was painted in the same color (i. 114). To the Sioux and Southern Dakotan tribes red symbolizes not war only, but also the sun, the forms of animal and vegetable life, and the procreative power. To the same tribes *yellow* represents the sunlight as distinguished from the fructifying energy of the sun.‖ By some tribes of Central and South America the face of the sun-god is painted white; by others, red, ruddy, or yellow.

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* Alice C. Fletcher, in Rep. Peabody Museum, iii. p. 285.

† Bradford, Amer. Antiq., 189 (quoted by G. Brühl, Alt-Amerika, p. 215).

‡ Milfort, Mémoire, p. 211.

‖ Rep. Peabody Museum, iii. p. 283, note. On *green*, cf. p. 84, note 8.

Red is also the color which strikes the eye with the greatest intensity, because its light waves possess more width than those of all the other colors. This is the cause why red is used in preference to other colors for signals on lighthouses, military signals, and flags. The red flag is the symbol of the Red Republic, or terrorism, not only because red means blood, but because red tickles our eye more than other colors, producing less undulations in a second than all the rest of the colors. Several languages, as Spanish, use the word "*what has color*" for the adjective red. The term *red* often receives preference over other colors approaching the red; for instance, a German will not speak of a "yaller dog," but only of red dogs; and the Germans of the middle ages said *rôtes gold* for yellow gold.† The Indian languages seldom have different terms for each shade of red as we have, but call them all by the same term *red*. It would be a very interesting task to trace the uses, superstitions and symbolisms connected with this color throughout the various nations of the globe. Primitive and half-cultured nations are addicted to its use in their dress and ornaments, for it strikes their eye and their fancy withal. The Seneca chief Red Jacket received that name from a scarlet garment given to him by a British officer, which he was proud to wear in preference to any other article of dress. One of the skeletons discovered in the prehistoric cave of Mentone had its bones deeply impregnated with a red color or paint which must have been applied, after removing the flesh, shortly after death.

Fire-worship and the mystic connection existing between the sun and the fire-flame, a subject in many points comparable with the one just treated, formed an important part of the Cha'hta religion. Of this we possess a circumstantial and trustworthy account in the Boston "Missionary Herald" of 1828, pp. 178–183, of which the main features may be given as follows:

Fire acts the part of an informant to the sun; it will tell the sun if anything wrong is done in its presence, for a constant intercourse is going on between the two. Symbolically fire is called in Cha'hta shá'hli míko (for míngo?), and hă'shi ititchápa, "the sun's mate"; shá'hli points to frequence, plenitude, addictedness to. Solar cult is preëminent among the Cha'hta Indians; anciently "they found the bright path to victory through the sun, and reached home safely after warring." These words formed a conventional way of addressing the people used by war-leaders. Their belief was that the sun, or "the man above," holds the keys of life and death, and that all the benefits of which mankind participates come from him. Still the people showed no gratitude to the sun for benefits received, when in prosperous circumstances. The four names now given to the God of the Christians are all the echoes of heliolatric or other pa-

† The numerous American water-courses called *Red river* are anything else rather than red.

gan conceptions: (1) nana-písa, "director, judge"; (2) istahúllo tchíto (also used of witches) and nanishtahúllo tchíto; (3) hásh tá'hli, from há'shi, *sun:* tá'hli, *to complete an act:* (4) yúba paík, "our father above." A ghost they call shílup; and the proper meaning of shilámbish, now *soul*, is *shadow*.

From all this it appears that the Great Spirit was supposed to reside in the sun, and that he was the Sun-god himself. Although the Great Spirit, or the Isákita immíssi of the Creeks, was therefore practically identical with the Sun-god and the sun itself, a formal distinction between it and the sun was always made.* Thus when the head chief of the Creek confederacy wanted to conciliate the Alibamu towns in 1813 in favor of the United States Government, he dispatched a runner to them with the following message:

> You say that the Great Spirit visits you frequently; that he comes in the sun, and speaks to you; that the sun comes down just above your heads. Now we want to see and hear what you have seen and heard. Let us have the same proof, then we will believe. You have nothing to fear.†

A singular instance how fire could become sacred among Indians is given in "Life of Black Hawk" (1834), pp. 17. 18. The great-grandfather of that famous Sak chief proclaimed during a violent thunder-storm, that this storm had been caused by him, and that it exemplified the *name* given to him by the Great Spirit, this name being *Thunder*, Nanámaki. A stroke of lightning then set fire to a tree close by; Nanámaki brought some of its burning branches to the lodge, made a fire and seated his brothers around it; thereupon, being the holder of the medicine-bag in the tribe, he repeated the statement in an address to his people, that the Great Spirit had made that fire through him.

"ON THE MOUNTAIN WAS A POLE," etc. The restless pole is one of the various camp-signals in use among primitive nations. It is mentioned in the migration stories of the Chicasa, Cha'hta and Creeks, and the manner in which it worked, or was worked,

* Compare what A. H. Sayce, "Anc. Empires of the East," p. 267, says about Persian fire-worship: "At one time, no doubt, fire itself was worshipped like the primitive Aryan hearth on which it had originally blazed, and Atar, the fire-god, held high rank among the Zoroastrians; but eventually it became the medium through which the worshipper approached his deity."

† Pickett, "History of Alabama," ii. pp. 250-251.

is described above under "Migration Legends." The passage in our legend merely hints at it.

In perusing this passage all our readers must have instinctively thought of the Hebrew camp-signal, described in Exodus and Numeri as "the pillars of cloud and of fire," which answered the same purpose as the restless pole among the Maskoki nations. A few quotations from the Bible will put this in evidence:

Exodus xiii. 22: "The Lord went before them by day in a pillar of cloud, to lead them the way, and by night in a pillar of fire, to give them light; he took not away the pillar .... by day nor by night," etc. Exod. xl. 37: "When the cloud was not taken up from over the tabernacle, then they journeyed not till the day that it was taken up."

The other passages referring to the pillar are Exod. xiv. 19. 20; xxxiii. 9; xl. 34–36. 38. Num. ix. 15–23; x. 34; xiv. 10; xvi. 42. 43. The leading idea is the supernatural guidance of the migrating people through the perils of the countries traversed.

Father P. J. de Smet, "Missions of Oregon," p. 114 (Gand, 1844), relates an interesting custom in vogue among the Cree Indians of Canada, involving a superstitious belief not unlike that of the Maskoki:

The Crees in their expeditions against the Black-feet will band the eyes of a girl, put her at the head of their armed force, and follow her south or north, in fact anywhere and to whatsoever point of the compass they see her going; for the manitou of war is supposed to guide her, and this inspires them with full confidence.

An oracular fetish giving to the Hurons or Wendát the direction in which they had to migrate is described in a curious and very ancient legend of that people, published by Mr. H. Hale in the "Magazine of Amer. History," N. Y., 1883, p. 479. They then lived near Quebec, where their forefathers first "came out of the ground." Their 'king" Sastaretsi led them on their westward journey as far as Lake Huron and died there.

He had left orders that the people should make an image of him, to be set on his grave. They did as ordered, carved an oaken image exactly resembling the defunct chief, clothed it in his dress of deerskin, adorned the head with plumes, painted the face like the face of a chief, and planted the image upon his grave. When the rays of the rising sun first struck the carved block, the assembled people saw it turn with such force from the east to the south, that the timbers between which it was fastened groaned and trembled as it moved. A southern direction had been prescribed by him orally and on a birch-bark map made by himself for their future migrations, and the miracle on the wooden simulacre, witnessed by all, determined the Hurons to set out in their canoes in the appointed direction toward Lake Erie, where they settled and stayed for more than a century.

"THEY TOOK A MOTHERLESS CHILD AND STRUCK IT AGAINST THE POLE," etc. This conveys the idea of a human sacrifice to propitiate the unknown power which moved the pole. Motherless children are left among Indians to the uncertain care of relatives, and, when the mother of a new-born babe died, several tribes (as e.g. the Kalapúya of Oregon) were in the habit of burying the *forsaken* child alive with the corpse of the mother — an instance of aboriginal feeling of humanity! A motherless child is also exposed as a bait to the isti-pápa whom the tribe intended to capture and kill. The Creeks in the Indian Territory still remember this incident of their migration: they state that the child was an orphan of the female sex, and that it was fastened to a rope in such a way that it could be suddenly jerked off from the attack of the isti-pápa. Thus the monster was compelled to take another bound at it, the pit-fall lying just underneath the human bait; so the Indians were sure to see the beast fall into the trap dug for its destruction.—The original German text conveys the idea, that *the pole* killed the child by its swaying motion; Brinton's translation and our Indian texts have "thus (they) killed the child."

PÁSSA, or *button-snake root*, is Eryngium yuccæfolium, a plant with a white flower, long jagged leaf, serving as an emetic to the Creeks. The infusion was drunk by warriors starting for war, by youths when undergoing initiation and after having received inspirations from the Great Spirit through prophetic dreams. It was probably the greatest of their "medicines" after the black drink, and is mentioned among the plants tendered by the mythic hayayálgi to the early Kasí'hta, Kawíta, and Chicasa, as a gift for some particular gentes (Hawkins, pp. 76. 79. 82). It was prepared on the first day of the Kasí'hta busk during the turkey-dance, and drunk in the afternoon; cf. i. 173. 177. 179. 186. A weed popularly called "snake-root" or "fern snake-root" was the sinika of the Cheroki. (Adair, Hist., p. 235.)

The disclosure of the medicinal properties of this and the three other plants was made by the *oracle* of the plants' "singing." This forcibly reminds us of the following passage in Philostratus, Apollonius of Tyana: "Was not Esculapius the son of Apollo? and was it not through his oracles that he discovered the several remedies for diseases, and herbs for wounds?" Cf. Jour. Roy. Asiat. Soc'y, xvii. p. 98.

Míko huyaní'dsha (or huyani'tcha), popularly interpreted by "king physic," is a tree or shrub, the roots of which were made to act as an emetic. Dr. Baldwin, who visited the Creek Agency in 1812 or 1813, declared it to be the dwarf willow. Pickering, Hist. of Plants, p. 777, makes it *Salix tristis;* "the root bruised in a watery infusion as a tonic, becoming an emetic when used freely." Hence Mr. W. R. Gerard concludes that it was either *Salix tristis* Ait., or more probably *Salix humilis* Marshall, both having been used as medicines. A legend states that it was given by the hayayálgi (q.v.) to the Kasi'hta, Kawita, etc., and was intended to belong to some particular gens. It belongs to the fourteen plants serving as ingredients for the war-physic prepared on the last day of the Kasíḥta busk, and was drunk in an infusion or mixture during four days in the council-house by warriors before starting on the war-path (Hawkins, pp. 77–82). The legend mentions it as "Micoweanochaw, red-root," as the second medicinal herb discovered by the migrating tribe.

Sowátchko is described by Mrs. A. E. W. Robertson as "an herb about three feet high, with blue flowers about an inch in length, having a root with a bitter taste." W. R. Gerard thinks it is the *blue flag*, *Iris versicolor* L., the root of which was used by the Southern Indians for dropsy in combination with the buttonsnake-root or pā'ssa. The root, which is very bitter, was eaten by the young warriors for four days before starting on the war-path, and had an intoxicating and maddening effect. Boys also ate the root and drank the infusion during the year of initiation; cf. vol. 1, p. 185; Hawkins, pp. 78, 79. The modern Creeks, who used this potion in their busk up to recent times, state that its preparation lasted eight days, and that only a few persons were allowed to drink of it.—In the legend the plant is mentioned as "sowátchko, which grows like wild fennel," and was one of the four plants which disclosed their virtues by singing. The words "which grows like wild fennel" were not rendered in our Creek and Hitchiti texts.

Ássi Lupútski, or 'small leaves," abbr. *ássi*, is the name for the Ilex cassine (cf. Black Drink), but here it is meant for a plant also called the *old man's tobacco*, isti atsúli pákpagi; its leaves were prepared as a ceremonial physic on the first day of the Kasi'hta and other busks, and distributed in the square on the last day; c.f. vol. i. 179. 180. The impressive ceremonies enacted on the last day show the high esteem in which the plant was held among the Indians, and we must regard them as equivalent to a *tobacco sacrifice*, so prevalent among all Indians, although here the seed and there the smoke of the weed is the object of the sacrifice. To the Creeks, however, the smoking of the pipe also was a religious custom; for the first thing they did was to puff smoke from the great pipe or calumet towards the sun. One instance of tobacco sacrifice, taken from the Naktche customs, may give a general idea of this rite among all other Indians. Among that people the Great Sun, who was the chief and also the first among the priests (as we can express it), appeared every morning at the door of his cabin, and, turning toward the east, "howled three times," bowing down to the earth. Then a calumet, used only for this purpose, was brought to him, and he smoked, blowing the smoke first towards the sun and then towards the other three quarters of the world. Charlevoix, Letters, p. 315, and Le Petit, in Histor. Coll. of La., iii., note to p. 142.

The great variety of uses to which smoking-weeds, generally called *tobacco* by the whites, were put by the Indians, easily explain themselves by the *variety* of the weeds. The Northern Indians used other plants than the Southern, those of the West other than those of the East. The kínnikinik of the Algonkins around Lake Superior, consisting of the bark of the red-willow and of the leaves of *Uva ursi*, was well known throughout the North, but probably differed somewhat from the petun cultivated by the Hurons. The leaves smoked by Indians generally consisted of a *mixture* of different leaves. The narcotic effects of all these preparations differed among themselves, and were the real cause of its sacrificial importance. Tobacco smoke was blown at persons, to place them into a stupor, by conjurers of the West

Indies. The ancient Virginians narcotized with it the fish in their ponds or rivers, and, when surprised by a tempest, they scattered it upon the excited waters, or threw it up into the air, to allay the wrath of the deity who had stirred up the tempest.*

The Indians on the Lower Mississippi had peculiar ceremonial rites connected with speeches, long chants, processions in costumes, etc., when an ornamental pipe was presented and smoked at peace treaties, conventions, the welcoming of guests, superiors, etc.; this was called "singing the calumet," or "chanter le calumet." The tobacco-worship most frequently observed among the prairie Indians of the West (Comanches, Káyowē, Tónkawē, etc.) is that of puffing the smoke first to the east, then to the south, west, north, zenith and nadir. Usually they perform this ceremony in an unconcerned and hardly perceptible way, so that strangers not acquainted with the custom scarcely become aware of it. The last two directions show that the ceremony is an act of sun-worship, for they indicate the position of the sun at midday and at midnight.

Whenever the Creek conjurer desires to obtain anything by jugglery, he takes a fawn's skin, puts into it sumach leaves, horsemint and common tobacco, places it around his neck and then sings his conjurer's songs. These three ingredients form the smoking tobacco of the Creeks, and sumach leaves make up more than one-half of the mixture.†

Other Physic-Herbs were the following: Twigs broken from the *cedar-tree*, atchína, served in ornamenting the heads or head-dresses of the people at festive occasions. It also belonged to the fourteen plants serving to concoct the infusion drunk on the last day of the Kasí'hta busk, and was among the plants exhibited by the mythic hayayálgi‡ to the early Kasí'hta, Kawíta, etc. people.

Another plant in use among the Creeks as a medicinal herb was the *Asarum virginicum*, called by them "lútcha lúbi 'láko,"

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* A long series of facts concerning the Indian use of tobacco will be found in Müller's "Urreligionen," Brinton's "Myths of the New World," and in L. Carr, "Mounds of the Mississippi Valley" (Kentucky Geolog. Survey, vol. ii. p. 51 sqq.) On the applicntioa of tobacco, cf. F. W. Putnam in Capt. G. M. Wheeler's Reports, vol. vii. p. 24 sqq.

† Communicated by Gen. Pl. Porter of Wialaka.

‡ To hayayálgi compare the Creek term hayáyagi, *light, radiance.*

or "large turtle liver." Cf. Pickering, "History of Plants," pp. 776. 777.

Tóla or túla, commonly called "*sweet-bay*," is Magnolia glauca L. (W. R. Gerard), Ch. Pickering, "History of Plants," p. 908, identifies this magnolia with Strachey's "tree that beareth the rind of black synamon," which he had seen in Virginia (p. 142). Mentioned among the four plants exhibited by the hayayálgi, and also among the fourteen plants composing the ritual mixture drunk on the eighth day of the Kasi'hta busk; Hawkins, Sketch, p. 77. The term is Creek, and has passed into the Timucua language; it signifies "felled," since beavers are in the habit of gnawing it to serve them in damming up water-courses (túläs *I fell, cut down*).

The *fourteen medicinal plants* (vol. i. 178. 179) entering into the composition of the liquid drunk from the medicine pots have been partly identified by Mr. W. R. Gerard. Kapapáska is the *spice-wood*, Lindera benzoni Meisn.; u-i láni is *worm-seed*, Chenopodium ambrosioides L., var. anthelminticum Gray, and the Jerusalem-oak belongs to the same genus. He further conjectures that No. 8 is the *cinquefoil*, Potentilla canadensis, and No. 10 the *angelica*, Ligusticum actæifolium. The list of plants was then submitted by Mr. Gerard to Mrs. A. E. W. Robertson, a successful missionary teacher among the Creeks, whose results, after consulting with the natives, were as follows:

No. 6 should be written túkfun lásti; it is *bur marigold*, Bidens frondosa L. No. 7 is the *cardinal flower*, Lobelia cardinalis L. No. 10 is *ginseng*, Panax quinquefolium L. (The Creeks ascribe special virtue to the forked root, and Charlevoix reports a belief of the Northern Indians, that it rendered their women fertile; its Algonkin name is inini waganashk, *herb in the shape of a man* (Cuoq), its Mohawk name tekarentoken, *separated legs and thighs*, G.) No. 11 is literally *fire-mouth-hair*, *fire-beard*, and is a fungus, not a moss. No. 13 is literally "something with which salt may be used"; the use of salt is prohibited during the busk. No. 14 is the "young and tender cane" of Arundinaria macrosperma Michx., called koni in Cha'hta.*

Scalping was a general war-custom among all tribes of North America east of the Rocky Mountains, and is also traceable to some Oregonian and Shoshóni tribes, while it was not practiced by the

* Correspondence of Mr. Gerard, dated New York, Jan. 24, and Feb. 24, 1884.

Central and Southern Californians. The Uta Indians remove only a small patch of skin from over the left ear of the conquered enemy. The Eastern Indians practiced scalping from the earliest historical period, for René de Laudonnière noticed in 1564 the smoking and drying of scalps by the savages of Northeastern Florida, about the mouth of St. John's river. Each tribe pretends to have adopted this custom from some other tribe once engaged in warfare with them. The Creeks took it, as they say, from a northern tribe, and possess a Creek word for the scalp, íka há'lpi, "his head's skin"; and another term, said to be of foreign origin, tíwa, *hair*. The reason why they assign a foreign origin to this practice adopted by themselves, is the same as the one given by anthropophagic nations for denying the eating of human flesh.

A tradition of the older people relates, that, to prove their success before their fellow-warriors, the Creeks first cut off the hands of the slain as trophies; but the hands were, while being carried off, clinging to bushes and trees, and so they exchanged that custom for that of taking scalps. By a ligament on the *top* of the head the scalp is fastened more firmly than on other portions of the head, and that sinew had to be severed by the knife. The one who struck the hostile warrior first did not always obtain the scalp, but the one who took off the scalp often had the honor of the killing; at other times all the men present were credited with the deed. A war-whoop, uttered when scalping, was the following:

Háyu mídshaχan stá!

The words are not Creek; but their meaning is said to be, "that's the way to do!" Another utterance proferred in the act of scalping, was

Wópopo pá! wápopo pá!

which is evidently interjectional, and therefore meaningless.

The pole, which the four rivalizing tribes endeavored to cover up with scalps taken from the enemy, seems to have been different from the átasi, but probably of the same length. If so, Tchikílli probably used another term than púkabi to designate it. The átasi still exists in many different forms in the western tribes, as Sioux, Saks and Foxes, etc. The Otoes call it naⁿ pásda, and it is made of the hardest wood obtainable.

"ABOUT THAT TIME A DISPUTE AROSE," etc. Disputes to the same effect were often raised during and through the athletic intertribal games so frequently mentioned in Indian annals. They are very popular among the Northern and Southern tribes, being in fact contests to show the physical superiority of the contending parts. The vanquished party often raises angry disputes which end in sanguinary conflicts, and have sometimes resulted in the secession of whole sections from a mother tribe. The war of the Senecas against the Eries originated in the defeat of the former in one of these national games. In recent times the Cheroki, Cha-'hta and Creeks had conventions for the same purpose, especially for playing ball. There was a ball-play about 1855 on Blue creek, in the Kawita district, on Arkansas river, when the Creeks and Yuchi beat the Cheroki players. A scuffle ensued, in which the Cheroki came out "second best," ball-sticks being used as weapons. During the secession war many ball-plays took place at Fort Gibson. The Yuchi Indians have ball-plays and wrestling-matches every summer two miles from Wialaka.*

A cricket game called tíngga exists in the Fiji islands, and often terminates in quarrels and bloodshed. (H. Hale, "Ethnology of the U. S. Expl. Exp.," p. 69.)

THE BLUE LONG-TAILED BIRD which preyed upon the people is an enigmatic being, which, from the long tail and the red rat issuing from it, may with some probability be identified with the storm deity, the *Thunder-bird.* His meeting with the image of a female brought into the way of the bird would then be the storm clouds meeting together, and the red rat the lightning proceeding from the union of the clouds. People were killed by strokes of lightning, which are symbolized by the arrows of the bird. To explain the term *blue*, it is necessary to know which term was used by Tchikilli himself—holátla or oχoláti? The inference is that the dark color of the storm cloud is meant by it. Possibly the bow of the bird is the rainbow. Storm-clouds are personified in several American religions by sorceresses and women destructive of mankind (Aztec, Iroquois, etc.); here, the hurricane with its long train of dust is indicated by the long tail of the miraculous bird. A bird analogous to our fúsua 'láko is mentioned in an

* Communicated by Gen. Pl. Porter, at Wialaka.

Iroquois myth made public by Mrs. E. A. Smith in American Antiquarian, iv. 36.

THE EAGLE, lámhi—in Hitchiti, hadshitúlami—is here placed in juxtaposition to the thunder-bird. He is regarded as a mighty bird (great king) and as a bird of peace, for his white feathers outnumber the red ones. Of the southern species of eagles described by W. Bartram (p. 8), the bald eagle* is meant here, not the grey eagle. The symbolic meaning of the eagle's feathers among Southern Indians is made plain by a passage in the speech delivered by Tomochichi, when presented to King George II. in 1734:

> These are the feathers of the eagle. which is the swiftest of birds, and who flieth all round our nations. These feathers are a sign of peace in our land, and have been carried from town to town there; and we have brought them over to leave with you, O great king! as a sign of everlasting peace.

And on another occasion he said to Gov. Oglethorpe:

> The eagle signifies speed, and the buffalo strength;......that the feathers of the eagle were soft and signified love, etc.†

But the eagle is, more especially, a bird of peace, because its feathers are *white;* and the legend further states,

> If an enemy approaches with white feathers and a white mouth,‡ and cries like an eagle, they dare not kill him........ The Palachucolas gave them (the Cussitaws) white feathers and asked to have a chief in common.

To dream of eagles is of good foreboding among most Northern Indians. The Kalapúyas of Oregon believe that dreaming of eagles will make them rich, or, what amounts to the same thing, make chiefs of them. Tail- and wing-feathers of that bird sell at fair prices. The eagle also occurs in Creek names: Lámhi tcháti or Red Eagle was the name of William Weatherford, the leader in the war of 1813–1814.

ISTÍ-PÁPA, or "man-eater," may be used to designate any large carnivorous animal, as the alligator, tiger, or lion; or monsters which are creations of the imagination. The mythic animal referred to in the legend is generally rendered *lion* by the modern Creeks, who have other stories about him, and the par-

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* Haliaëtus leucocephalus. † Ch. C. Jones, Tomochichi, p. 64.

‡ Spittle flowing from the mouth.

ticulars given here apply to one of the larger quadrupeds. The legend gives this story merely for the purpose of explaining the origin of that part of the war-physic which they kept in their shot-bags, and which served as charms, amulets, or talismans: the lion's bones and the snake-horns. As there is no lion in America the man-eater should be more properly called a cougar. The idea of using this feline's bones as charms is, that he is one of the strongest and pluckiest beasts, and that therefore taking his bones with them would inspire the warriors with courage and fortitude. For the same reason many primitive nations take with them in their migrations the bones of their ancestors and celebrated men. The Hebrews took with them Joseph's bones when leaving Egypt, and the Roman Catholic church preserves the bones of its saints to prompt its followers to acts of piety and devotion by the presence of body-fragments of their illustrious characters.—Another instance of Indian man-eaters is furnished by two women of the giant-race, or Elip-tílikum, who *ate up* all those that passed in the vicinity of their home, and were put to death by a bird sent by the Great Spirit and changed into rocks, which now stand on Middle Columbia river: cf. G. Gibbs (in Pacific Railroad Rep., i 411) who calls them *lions*. The Fiji or Viti people, who never saw lions in their islands, call them ivóla ni tamáta, "man-eaters."

THE SNAKE-HORNS

or tchíto yábi made up the other portion of the war-physic contained in the Creek warriors' shot-pouches. These horns belong, as alleged, to a species of water-snakes seldom found, and therefore exciting more curiosity. "This beast was the last thing which our ancestors ever conquered" is the assertion of the modern Creeks. When the snake was seen in a blue deep hole filled with water, the old men of the tribe sang their incantations, and the snake came to the surface. They sang again, and it emerged a little from the waves. When they sang for the third time, it came ashore and showed its horns, and they sawed one off; again they sang, and it emerged for the fourth time, when they sawed off the other horn. Small pieces of the horns and the man-eater's bones were carried along when going to war.* One of the charm songs

* Cf. Hawkins, Sketch, pp. 79, 80: Chief Chicote tells me that the snake-horn was a

referred to the calling of the snake, another to its coming ashore, another to the removal of the horns, another to their placing into the "medicine"-bag, and the last to the starting off with them. The refrain was "kíti weihi, áhayi," the first two words being repeated several times before "áhayi" was sung.†

WAR-FETISHES.

Milfort states that commanders of the smaller war-parties (pakā'dsha) were obliged to carry upon them a small pouch containing certain stones and a few shreds from the garments of the "great warrior" obtained from him after the return from his last expedition.‡

War-talismans or -fetishes of a similar character, as the lion's bones and the snake-horns, were in use among the Cha'hta warriors of the eighteenth century, and are described by Capt. B. Romans (Florida, p. 76) :

> On war expeditions they carry with them a certain thing which they look on as the genius of the party; it is most commonly the stuffed skin of an owl of a large kind; they are very careful of him, and offer him a part of their meat; should he fall, or any other ways be disordered in position, the expedition is frustrated; they always set him with his head towards the place of destination, and, if he should prove to be turned directly contrary, they consider this as portending some very bad omen, and an absolute order to return; should therefore anyone's heart fail him, he needs only watch his opportunity to do this, to save his character of a brave or true man. There is also a species of Motacilla, or finch, whose chirping near the camp will occasion their immediate return.

The medicine-bundle of the Kaúi, a division of the *Páni* Indians, contained the following articles:

> A buffalo robe; skins of the beaver, mink, and otter; the skull of a wild-cat; stuffed skins of the sparrow-hawk (as a symbol of bravery) and of the swallow-tailed fly-catcher, *Milvulus forficatus* (a sacred bird); several bundles of scalps and broken arrows taken from enemies; a small bundle of Páni arrows; some ears of maize, the symbol of their agricultural interests, and a few wads of buffalo-hair, as found in wallows. Each Páni

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hunter's charm only, not a "war-medicine." But among the participants of a war or raiding party there were always a few who provided for the subsistence of the others by hunting game, and this would account for its being regarded as a war-charm.

† Chicote sang the refrain as follows: kitiwaíhi, kitiwaihi — yá hayi. Cf. what is said of the imissi.

‡ Milfort, Mém., 243, 244.

division had a medicine-bundle, kept by the conjurers, and carried about in all general expeditions.*

"After four years they left the Coosaws," etc. We need not feel any surprise at the slow progress made by the Kasi'hta people migrating East, encumbered as they were by their families. A parallel to this slow progress we find in Adair's History, p. 410, who, in the middle of the 18th century, met a part of the main camp of the Sháwano about fifty miles northeast of the Chicasa country, "consisting of about 450 persons, on a tedious ramble to the Muskohge country, where they settled, seventy miles above the Alabahme garrison; they had been straggling in the woods for the space of four years, they assured me." Nevertheless they all looked hale and healthy; evidently they were not in a hurry to complete their march.

"The people had flattened heads," etc. Artificial deformation of the skull during infancy is a custom practiced by many American and foreign tribes, and in very different ways. We find it on the Pacific coast, between the 44° and 54° of northern latitude, extending from the shore line to some distance inland. The Maya people practice it, and the Quichhuas managed to elongate the skull by compressing it on all sides. By a soft pressure of the hollow hands, the mothers of the Greenland-Eskimo tribes compress the tender skulls of their infants shortly after birth, to hasten the concrescence of the sutures, and do not repeat the process afterwards.

In the southern parts of North America, the tribes which practiced this custom upon their infants were the Shetímasha, Caddo, Koroa, Náktche(?), Cna'hta, the tribes of the Creek confederacy, and the Waxsaw, a Katába tribe, and many other Katába tribes as well.

No distinct notice can be found in the early writers that the *Creeks* flattened the heads of their children. But Chicote, a Creek chief of Hitchiti origin, now (in 1884) sixty-five years old, and one of the few surviving men who has seen the Creeks when living in their old country, affirms that all their tribes observed the custom of flattening the infants' heads *behind*, by fastening them upon the hard wood of the baby-board. This, of course, made the deforma-

* John B. Dunbar, "The Pawnee Indians," Mag. of Amer. Hist., 1882, pp. 734-756 (§ 8).

tion less conspicuous to visiting strangers than if their foreheads had been flattened. De Soto and his soldiers witnessed the flattening of children's heads in one of the southern tribes, and Garcilaso de la Vega (Florida iv. ch. 13) describes this deformity as consisting in an upward elongation of the cranium until it terminated in a point or ledge.* Le Page du Pratz (History, p, 323) describes the process. The name of the Caddo tribe of the *Nataché*, mentioned by L. d'Iberville in 1699 on Middle Red river.† seems derived from the Cha'hta term natassé, *to press*, *squeeze*. The Koroa also observed this custom. The *Shetimasha* on Grand Lake, Louisiana, flattened their infants' heads so as to shape the occiput round, the forehead flat.‡

The *Cha'hta* practice is described by Adair and W. Bartram, and to the traders this people was generally known as Flatheads, or Flats, all the *males* (as among the Aimará) having the fore and hind part of their skulls artificially flattened. The latter author describes the process as follows (Travels, p. 515):

> As soon as the child is born, the nurse provides a cradle or wooden case, hollowed and fashioned to receive the infant lying prostrate on its back, that part of the case where the head reposes being fashioned like a brick-mould. In this portable machine the little boy is fixed, a bag of sand being laid on his forehead, which, by continual gentle compression, gives the head somewhat the form of a brick from the temples upwards; and by these means they have high and lofty foreheads, sloping off backwards. These men are not so neat in the trim of their heads as the Muscogulges are, and they are remarkably slovenly and negligent in every part of their dress, etc.

Concerning the head-compressing of the *Waxsaws* in South Carolina, Lawson (Hist. of Carolina, p. 33, 1701) states that

> they use a roll, which is placed on the babe's forehead, it being laid with its back on a flat board, and swaddled down hard thereon from one end of this engine to the other. The instrument is a sort of press that is let out and in, more or less, according to the discretion of the nurse, in which they make the child's head flat. It makes the eyes stand a prodigious way asunder, and the hair hangs over the forehead like the eaves of a house, which seems very frightful.

Du Pratz says that the term Flatheads is generally understood

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* Cf. Schoolcraft, Indians, ii. 324.
† L. d'Iberville, in Margry, iv. 178.
‡ Cf. Transactions of Anthropol. Soc'y of Washington, vol. ii. p. 153.

to mean the Cha'hta only; but he could not perceive any good reason why it should be limited to these, " since the practice was so general and wide-spread" among all the southern tribes.

In questioning the Indians themselves for the cause of this deforming custom, which in Columbus' time was practiced probably by one-half of all the American tribes, we obtain very different replies. The Kalapúya of Oregon state that a compressed forehead gained in extent, so that more beads and ornaments could be suspended in the hair around it, and that it improved the face. Lawson was told by the Waxsaws that the practice improved the eyesight enormously. Others assert that it *straightens* and fortifies the bodies of the children. The intellectual faculties seem to be neither benefited nor impaired in any degree by the process, but the concrescence of the sutures is evidently retarded by side-pressure. The Aht tribes of Vancouver Island imagine that the flattening of the head improves the appearance, and also gives better health and greater strength to the infant.* Many tribes regard it as a token of dignity and nobility, and hence do not flatten the heads of the slaves born among them.

The true cause of the custom probably lies in the almost universal use of the wooden cradle-board. The mother or nurse, in carrying the child on her back, or leaning it against a tree, rock, etc., when working in the field, soon invented a contrivance to keep its head up to prevent it from sinking down, and thereby from being injured or choked to death. This was accomplished by a strong tie fastened around the head and attached to the baby-board. When the muscles of the infant's neck became stronger, the practice was discontinued. The mothers probably did not at first intend to flatten the heads of their infants; but, since this was the necessary result of the practice described, and the "fait accompli" could not be changed, they finally thought the alteration to be desirable and even beautiful. Thus the custom of head-pressing may ultimately have become general.

"BUT THE PALACHUCOLAS GAVE THEM BLACK DRINK AS A SIGN OF FRIENDSHIP," etc. The use of this renowned decoction was so wide-spread among the Indians of the Gulf States, that only a

* Sproat, " Scenes and Studies," p. 29 (1868).

special notice of it can do justice to its peculiar influence on the life of the aborigines.

BLACK DRINK was prepared from the small and narrow leaves and the tender shoots of the shrub *Ilex cassine*, which grows spontaneously as far north as the 37th degree of latitude. The white people of the Carolinas prepare from it a sort of tea. The botanic name formerly given to the plant was Cassine yaupon, yaupon being a derivative from the Katába term yáp or yóp *plant, tree, shrub.* The name cassine was first applied, as Prof. Lester F. Ward informs me, as a generic name to a South African plant by Linné, and as a species name for an Ilex by Thomas Walter.* The plant and the decoction are called by the Shetimasha nuaít; by the Creeks, ássi lupútski, *small leaves*, which is generally abbreviated to ássi, *leaves.* The term *black drink* originated among the British traders. In Ch. C. Jones, Tomochichi, p. 118, it is called foskey.

Ch. Pickering, "History of Plants," p. 777, has the following:

West of the mouths of the Mississippi, Cabeça de Vaca found the Cutalchiches drinking a tea from the leaves of a tree like an oak; in West Florida "a decoction of it, called *liquor of valor*, was drank by the natives." The Shetimasha and Timucua conjurers used it to produce stupor and narcotic effects upon themselves; the Naktche warriors took it before starting on war-expeditions.

The Creeks made use of the ássi, as we do of fermented liquors, to promote conviviality; but it entered also into their ceremonies of religion and warfare, and at the Creek and Yuchi busk-festivals in the Indian Territory it is drank in the "great square" at the present time. But the black-drink potion was not always prepared in the same strength: the ancient Creeks had three modes of preparing it; the three potions resulting from them widely differed in strength according to the uses for which they were intended.

Small quantities of the young leaf, parched in a pot until it assumed a brown color, and boiled in a copious infusion of water, produced a liquor acting as an exhilarant and gentle diu-

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* *Linnæi* Genera, Ed. nov. No. 371 (1753); Systema naturæ, Ed. 13th (Lips. 1791), p. 497. *Thos. Walter*, Flora Caroliniana, Lond. 1778, p. 241. Dahoon is the name of another Ilex; Walter spells it *Duhoon*, others *houx d'Ahon.*

retic; it was drank by the people at the busk, and by the "elders" when assembled in council or when discussing every-day topics. After the potion has been poured from one pan or cooler into another, it begins to ferment and to produce a white froth, from which it is styled also *white drink*, the term "white" alluding simultaneously to its purifying qualities. To make the liquid stronger, a larger infusion of the parched leaves is required; it then assumes a dark hue, nearly as black as molasses, and acts as a powerful, intoxicating stimulant. A still larger addition of the cassine-leaf produces a strong narcotic, which was, as mentioned previously, used by conjurers to evoke prophetic ecstasis accompanied by dreams.*

The black drink of the weaker sort acts as an emetic, and was used as such in the annual busk and at other occasions extensively; this gave to the liquid its renown as a bodily and moral purificator, for primitive peoples are prone to regard agencies which act with mysterious force upon the bodily constitution as symbols for abstract, spiritual or religious ideas. This drink being served at all games and festivities, councils and conclusions of treaties, special ministrants, the Hinihalgi, were appointed for its manufacture by the míko of the town. On festive days they prepared it with peculiar ceremonies, and served it to all who attended the celebrations in the square.* The singing of the yahóla or *black-drink note* was, and is still, a peculiar rite connected with the drinking of this favorite liquid. It forms a part of the annual celebration of the púskita, or busk. Of this ceremony C. Swan has left a vivid description in his Report (1790) printed in Schoolcraft's "Indian Tribes," v. 266. 267, from which we extract the following:

Three young men acting as masters of ceremony (at the annual busk in the square), each having a gourd full of the ássi-liquor, place themselves in front of the three greatest chiefs or warriors and announce by the word "tchá!" that they are ready. After a short pause, stooping forward, they run up to the warriors and hold the cup or shell to the level of their mouths; the warriors receive it from them, and wait until the young men fall back and adjust themselves to give the yahóla,* or black-drink note. When they begin to emit the note after a deep aspiration of air, the "great

* Cf. Father Petit, in French, Hist. Coll. of La. iii. 146 (note).

* Cf. vol. i. pp. 177–183, and Hawkins, Sketch, pp. 71, 75, 76.

men" place the cups to their mouths and are obliged to drink during the emission of the note, which, after exhausting their breath, is repeated by the three young men on a finer key until the lungs are no longer inflated. This long aspiration is continued nearly half a minute, and the cup is surrendered at the instant the note is finished. The young men then pass the cups to others of inferior rank, exclaiming "tchá!" but omitting the yahóla note. At every meeting (in the square) the drink is generally served up in this manner three times; during the intervals the men sit quietly in their several cabins, smoking, conversing, exchanging tobacco, etc., and *disgorging* (to the distance of six or eight feet) the quantity of cassine swallowed by them.

The symbolic and religious qualities of the liquid are pointed out by the same writer, as follows (p. 266):

It purifies them from all sin, and leaves them in a state of perfect innocence; it inspires them with an invincible prowess in war; it is the only solid cement of friendship, benevolence, and hospitality; . ... a stranger cannot recommend himself better to their protection than by offering to partake of it as often as possible.*

Frequent allusions are made by all travellers and authors on Southern Indians upon the extensive use made of the ássi beverage. More details on it will be found in Urlsperger, Nachrichten i. p. 851; in Milfort, Mémoire, pp. 195. 197; in Adair, History, p. 108; Lawson, p. 90: also in Lindley, W. Bartram, B. Romans ("Florida," p. 94).

From the Aryan religions of India and Persia we may in some respects compare the worship paid to the juice of the Asclepias acida, or *soma-plant:*

The Haoma was the Soma of the ancient Hindus, an intoxicating plant which symbolized the powers of vegetable life, and the juice of which was drank by the faithful for the benefit of themselves and the gods (to strengthen the gods in their fight against the demons—*Schleicher*). Answering to the yellow haoma of earth is the white haoma of heaven, which will make men immortal on the day of resurrection. (Sayce, "Anc. Emp. of the East," p. 266.)

It will be appropiate to add two quotations of cassine-drinking, for being the *most ancient* mentions of this custom peculiar to America:

* Yahóla frequently composes war-names, like hádsho, fíksiko, and can stand first or last. The collective form of it is yahólalgi. Cf. Assi yahóla, or Osceola, in "War-titles," vol. i. p. 163.

A. N. Cabeça de Vaca describes in chap. 26 of his interesting *Naufragios* the boiling and drinking of the cassine upon the Texan coast by *men* only, and the superstitions connected with it when women approached or passed by.

Jean Ribaut, the French explorer of Eastern Florida, mentions in his report, first printed at Lyons in 1566, his own experience in tasting the beverage: "Leur boisson, qu'ils appellent *cassinnet*, se fait d'herbes composees, et m'a semblé de telle couleur que la cervoyse de ce pays [French beer]; i'en ay gousté et ne l'ay point trouvé fort estrange." Ternaux-Compans, Coll. xx. p. 263; and French, Hist. Coll. La., iii. p. 208. Cf. also Pareja, Timucua Grammar, Paris 1886, pp. xii. xiii.

"OUR HEARTS ARE WHITE, AND YOURS MUST BE WHITE," etc. *Ceremonial allocutions* embodied in standing formulas, which generally point to a high antiquity by the quaintness of their wording, were frequent among the Creeks and southern Indians. They served as exordiums of ceremonial speeches delivered on various occasions, e.g. at the commencement of the busk ceremonies, before playing ball, etc. The following was the usual formula at the beginning of a peace-speech held to arrange difficulties between towns or tribes, to stop warfare between belligerents, etc.: Antúfkita hátkusin, tchafíki hátkusin, tchánki hátkusin, 'tchimwáyēs (abbr. from atchimwáyäs)—*my spittle is white, my heart is white, my hand is white; I extend it to you.* Another formula was used in council-speeches, being also intended to show peaceful intentions: amatchúlaki intúfkitan ák'hui'lät—*the spittle of my forefathers, I stand in it.* When the dual of the verb húi'läs was used, it meant that he and the whole tribe or nation were unanimous in the feelings expressed by him. The colonists of the Salzburger Protestant settlement near Savannah, Georgia, observed among the Creek Indians there, or their affiliated tribes, a peculiar mode of salutation, which was accompanied by a motion of the right hand to the left breast, or by the offer of the calumet (Urlsperger, "Nachrichten," i. p. 862): tchahókpi tchihókpi itapómis; tsanádsi tchinádsin hámgusit ō's; tchafígi tchifígin hámgusit ō's; tchafígi tchifígin itiladshi-hí'lit ō's—*my breast is like your breast, mine and your chest is one chest, mine and your heart is one heart, my heart is intimately joined to your heart.**

* Retranslated from the English into Creek by Gen. Pleasant Porter. The two next allocutions I obtained from G. W. Stidham.

A Creek brave, who with others had removed west of the Mississippi and in 1830 lost one of his companions in a conflict with Caddo Indians, reported the loss to his people in the following strain, a portion of which rests on conventional phrases and sentences of figurative import: Tchánki wisáɩa tchaɩgíbat wéyät nági hí'lkusa'li kómait húi'län háyomād 'l(ō''lin), tchánki wisáɩa hámgad tadshä'kin húi'läs. Níni tcháti ánhahi sihóɩāt adshak'hui'la'lánayatalgid adshuktchaɩaigin húi'läs. — *Until that time I stood extending my hand, with the five fingers spread, soliciting peace; now I am* (or *stand*, húi'läs) *here with one finger of the spread-out* (hand) *severed off. I have to pursue those who have prepared the red path for me; and here I am, this* (revenge) *having been forced upon me.*

Another form of a ceremonial address, embodying the expression of intertribal courtesy, is reported from the early days of the Creek settlements. When the Kawita, then an erratic body of Indians, turned south they met the sedentary Hitchiti in their settlements. After the old men of the Hitchiti had hoisted a white object, probably feathers, as a sign of peace, they invited them to their square, and had them seated there. They prepared the black drink, ássi, and one man offered it to them. The newcomers refused the gourd or shell, and the ministrant threw the contents away, preparing a new dose of it. They refused this for the second and third time; but, after it had been prepared and offered for the fourth time, the Kawíta accepted it and drank of it. The Hitchiti concluded from this that they accepted their offer of friendship, and one of their men addressed them as follows: *I will take off your red moccasins and put white ones on your feet, brush your face with white feathers, whiten the posts you lean against, and show you the proper manner of raising children in peace.*

Ever since both tribes continue to be friends to this day; the Hitchiti even moved northward nearer to the Kawita, and from these new seats mutual visits were exchanged frequently.

As an exordium for speeches, the modern Creek Indians often used the following formula, which is of an archaic type: Itálua tóyayad, ántasikaya, impunäípat hí'läidshät ták'kāyäd — *to the town that I am of, my fellow-citizens, I speak with great con-*

sideration to those who have resided in it. This formula is rather conspicuous by the verbal dual *we two reside*, ták'kayäd, which under the symbolic image of man and wife represents the whole tribe, gens, or nation. It also occurs in another formula: wulhokᵢäíta itáluan ihayíyatis—*I seceded* (man and wife) *and formed a town for myself;* or, as the Creeks express it, *I two seceded*, meaning a part of the tribe including myself.

TOMOCHICHI, chief of the Yamacraw tribe upon Savannah river, was the brother of the Hitchiti míko, and cousin of Wikatchámpa, chief of the Okoni Indians. He was a native of Apalatchukla town, a Hitchiti-speaking community, and a steadfast friend of the white colonists who had settled in his vicinity. His name was spelt in many different ways; it is Creek, and signifies "the one who causes to fly up." When Gov. J. Oglethorpe took him over to England, he left Charleston harbor with a considerable retinue of Indians on April 7th, 1734, and on his return disembarked at Savannah on December 27th of the same year. All the portraits extant of him are taken from a German print, engraved by J. J. Kleinschmidt at Augsburg, and purporting to reproduce an original likeness issued in London, which full print also gives the portrait of his nephew Toonahowi—a boy holding an eagle. Toonahowi was the son of the above míko of the Hitchiti, and afterwards distinguished himself as a warrior in assisting the English against the Yámassi and the Spaniards. The portrait is reproduced in Chas. C. Jones, Jr., History of Georgia, vol. i. p. 134; in Gay, Popular History of U. S., iii. 147; in J. Winsor, Narrative and Critical History of America (1887), vol. v. 371.

THE TRACK OF THE KASI'HTA MIGRATION.

Does the Kasí'hta migration legend contain historic, real facts and occurrences, or not? and, if it does, which are they? The investigation of these points requires, before all, a close examination of the topical names preserved in the interesting narrative.

Although at the beginning of the migration the Kasí'hta made a move to the westward, the general direction of the march is from west to east, or, more accurately, as will appear from the following, from northwest to southeast.

When from the place of their "issuing" the Kasí'hta arrived at the "thick, muddy, slimy river," a one night's stay was made upon it, and the next day they came to the "red, bloody river." No mention is made of having crossed the "muddy river." U-i ukufki (if this term was used by Tchikilli to designate that water-course) is applied in Creek to any river or brook carrying discolored water, and need not, as has generally been done, to be taken for the Mississippi river, though it is the usual name for it. Wiogúfka, e.g., was an Upper Creek town of the same name, which was certainly named after a muddy stream in its vicinity. Thus many other water-courses of the same name may have existed west of Coosa river, one of which is alluded to by the present passage of the legend.

To throw more light upon the discutable topic of river-names in legends, I quote a parallel Iroquois migration legend, also alleged to refer to Mississippi river:*

When the Holder of the Heavens, Tarenyawagon, had brought out six families of the Iroquois Indians (which represent the tribes afterwards called the Six Nations) out of a cave near the falls of Oswego river, where they had taken refuge, he gave them instructions and laws concerning their future mode of living; he also warned them against the evil spirit, and distributed among them maize, beans, squash, potatoes, tobacco, and dogs to hunt their game. Following his directions, they came to the Hudson river and subsequently to Mohawk river, where the first of the families settled. The remainder going west, the second family then settled at Oneida, the third at Onondaga, the fourth on Cayuga lake, the fifth (now called Seneca) south of Canandaigua lake. The sixth family proceeded to the banks of Lake Erie, then turned to the southwest and journeyed for a long distance until it reached Onaweyoka, "the great stream," now Mississippi river.† In the attempt of crossing this broad water-course, they held on to a vine which they found stretching from shore to shore; but, after a portion of the people had floated and crossed over in this manner, the vine broke, they became separated from the rest and had to combat the hostile tribes on the western banks. The portion which remained upon the east side was led by Tarenyawagon across the Alleghany Mountains to Neuse river in North Carolina, where in time their language was changed. This is the Tuscarora branch of the Iroquois Indians.

When we examine this legend with the eyes of a critic, there is

* Elias Johnson, "Legends, etc., of the Iroquois," Lockport, N.Y., 1881, p. 43 sqq.

† This should properly be O'hnaweyókie, "at the great current," a term now designating Ohio river to the Tuskaroras and all the other Iroquois of New York. From o'hnáwä current; í-o, eyo great, -kie, kiä' locative suffix.

no need of hinting at the high improbability of this western march of a single tribe, and of its return east by retracing its own steps. Why does not the narrative mention any stopping-places upon the long march from Lake Erie to the Mississippi river, which includes a distance three times as long as that from the Hudson river to Lake Erie? Because the Tuscaroras never reached that river at all, and the term used here, Onaweyoka, designates any other *large* river just as well as it does the Mississippi. Thus the river from the banks of which they returned east may have been the Maumee, Miami, Scioto, Ohio, etc., to which the name may be applied as well.

The red, bloody river, U-i tcháti, which the Kasíˀta reached one day after, and by which they lived for two years, contains the Creek name for the Arkansas and the Red river of Louisiana, though here it necessarily designates some water-course to the east of Mississippi river. All rivers and creeks in the old Creek country are discolored by an admixture of ferrugineous mud, and especially after rains assume an almost blood-like shade of color. Thus U-i tcháti is of no topographic value to us. The Kasíˀta followed its current until they reached the thundering mountain, and there they met three other tribes, the Chicasa, Atilama (which, I assume with Dr. Brinton, stands for "Alibamu"), and the Ábi'hka. Sacrificial rites and the knowledge of remedial herbs were obtained there in a miraculous manner, and the contest for superiority, which was waged then by the four tribes, resulted in the victory of the Kasi'hta. According to the Alibamu tradition mentioned above (vol. i. 86. 87), this tribe came from the northwest into their later seats, and at the epoch referred to by Tchikilli's legend may have resided there still; the Chicasa lived in the old Chicasa country, near the northern limits of Mississippi and Alabama, the Ábika east of them. Thus following our legend word for word, we may assume that the Kasi'hta, at the spot where the large blue bird preyed upon them, were, conjointly with the three other tribes, somewhere near the old seats of the Chicasa and northwest of Kúsa town.

Near a rivulet called Coloosehatchi they found on their onward journey a white path leading through a white-looking country; even the grass looked white there. This may be a symbolic phrase for designating a country, the inhabitants of which subsequently lived on friendly terms with the Kasi'hta. Kolusa Hatchi is supposed by Dr. Brinton to stand for Tuskalusa Hatchi, the Cha'hta name for Black Warrior river, a large affluent of the Tombigbee river. The headwaters of this river really lie in the track of the assumed migration; but the text distinctly states that the stream was called so "because it was rocky there and smoked." I know of no etymology which could explain the term in giving it this signification.

The ancient and renowned town of Kusa (q.v.) was the next station which the Kasi'hta reached on their eastern journey. Kusa has always been considered as an ancient capital and centre of the Maskoki people; it appears as such in the documents extending from the 16th to the end of the 18th century. According to our legend, the settlement of Kusa is older than the Kasí'hta immigration; which means to say, that Creek Indians lived in the Creek country long before the Kasi'hta arrived there. The cause why Kusa is mentioned here at all, is that they obtained there the war-fetish of the *istipápa* = *bones*, having previously obliged the Kusa Indians by killing that dangerous "lion" in the ingenious manner described.

The local names now become more frequent. After leaving the friendly Kusa, the Kasí'hta reached Nófāpi or "Beech-tree" river, now called Kalasi Hatchi. The former name belongs to the Hitchiti dialect, and in Creek would sound Nifapi (all the vowels pronounced *short*); Kalasi hatchi, of uncertain etymology, was the name by which the stream was known in Tchikilli's time. This shows that the migrating tribe had then arrived within the limits of the country where some dialect of the Southeastern, Hitchiti or Apalachian branch was spoken *at that time*, though at a later period the use of Creek predominated there. A passage occurring in I. Gerar W. de Brahm* shows in which part of Alabama we have to look for this stream:

"Nophabee, Tukasatchee and Tallesee are towns between the first and second cataract [of Locushatchee, now Talepusee river]." Tukasatchee being misspelt for Tukabatchi in that document, which was written early in the 18th century, and is full of inaccuracies of this kind, we see at once that the "Beech creek" or Nófāpi must be in the vicinity of Tukabatchi and

* "Hist. of the Prov. of Georgia," Wormsloe, 1849 (fol.) p. 55.

Talisi. It is the stream called now Naufawpi, running from the east into Eufaubee (Yufábi) creek, which empties into Tallapoosa opposite Tukabatchi: in Hawkins' Sketch (pp. 27, 29) Eufaubee is made distinct from the neighboring Kalibi Hatchi, both of them running into Tallapoosa river from the east (Macon Co., Alabama); the country intervening was one of the most densely settled at the time of the aboriginal occupation of Tallapoosa river. The legend adds that the Kasi'hta had no maize at that time, and were therefore compelled to make use of their bows and arrows (pointed with beaver-teeth and sharp stones) to supply themselves with venison. The cane-knives were what the Cha'hta call kánshak; the tribal name Conchaques, mainly in use among the French colonists, is derived from this term (vol. i, p. 116).

No mention is made of the crossing of the Tallapoosa river; if the tribe followed the *southern trail* as known to us from the eighteenth century, they crossed that river at Tukabatchi.

The Crane-whooping creek, Watula-Hóka Hátchi, is a small northern affluent of Yuchi creek, also called Hosapoligee, which runs between Nófāpi and Owatunka river, a stream in which we recognize Wetumka creek (i. 150). This stream follows a southeastern course through Russell Co., Alabama, and falls into Chatahuchi river about 32° 15′ Lat., a few miles below Columbus, Ga. Wetumpka, an old town on Coosa river, cannot be meant here, for to reach it the migrating tribe would have had to retrace its steps westward; moreover, the inhabitants of Wetumpka were of the Alibamu race and language, a circumstance which makes the visiting of this place by Creeks improbable, even if it could be proved that Wetumpka existed at that early day.

The next stream visited and crossed by the immigrants was Afusafíska,* after which a hilly country was reached. The immigrants must have been then in the neighborhood of Kawita or Kawita Talahassi.

The Kasi'hta had now reached the mountainous tracts on Chatahuchi river, inhabited by red towns, or unfriendly, distrustful populations. The name of the first people they saw is not stated, nor is that of the second, whose town they assaulted and took by force. The difficulty encountered by them in pursuing a trail

* Afusafiska or "Bark-peeling." This name refers to the peeling of trees, especially coniferæ, to obtain the inner or fibre bark for food. This custom is wide-spread among Indians; the Ratirontake or Adirontaks (a Mohawk term) obtained their tribal name on account of peeling the trees in their country.

going through a water-course was nothing unusual then, for war-parties often walked for long distances through rivers, against or with the current, to conceal their tracks from the enemy. The Kasi'hta took this as a sign that they had to do with a people hostile to them.

The name of the mountain which made a noise like a drum is not Maskoki in this form, Moterell; for there is no *r* in Maskoki dialects (nor in Yuchi). This letter is probably meant for '*l*, but even then no known word suggests itself to explain the local name, which may refer to the noise heard. The war-custom referred to — the beating of a drum — is probably the only reason for mentioning that mountain in the context.

The fact that the population of the town which they captured had flattened heads does not help us much in determining its site or nationality; for, as we have seen in a former item, this custom was general among the Creeks, Apalachians, and Cha'hta. The only deduction to be drawn from the statement is that the heads of the invading tribe had not undergone this deformation.* The town was evidently situated in the vicinity of Apala'tchúkla, the friendly or white town which they had been seeking so long; according to Taskáya Míko's account, the captured town was at the mounds in the Kasi'hta fields, and the attacking tribe crossed the Chatahuchi river "at the island, near the mound."

The Creeks possess a tradition according to which they conquered the Núkfalalgi (or Núkfila) at an earlier period than the Yámassalgi, and that both peoples lived in the direction toward Florida (Íkana=fáski fátchan). But did the Nukfalalgi dwell on or near Chatahutchi river? if so, they may possibly represent the people spoken of in the present passage. My inquiries on this point met with no satisfactory reply; some thought that they had been of Creek origin. Kawita Miko, an aged chief, told me that Núkfila was the name which the Katába gave to this people, and that they roamed in the country anciently called Florida, but not in the point (peninsula); that the Creeks transformed the name into "Núk=hótsi," *spotted, marked on the neck*, taking over only the *nuk-* from the name, which they did not understand†; and

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* Dr. Brinton, Ch.-M. Legend, p. 7, thinks that this flat-headed race once inhabiting the mounds along the Lower Chatahuchi consisted of pure-blooded Cha'hta.

† Inukwa means *his neck*.

that in these eastern parts they also "conquered" the Apalaches and the Kalusi.

In colonial history the Katába tribes figure extensively under the name of *Flatheads*, and, if we insist upon the circumstance that the conquered tribe had *flattened heads*, we may consider it as an advanced outpost of that nation. Their settlements were east of Savannah river, but they are known to have raided the countries west of it. The Yuchi did not dwell on the Chatahuchi river before 1729, and were never known under the name "Flatheads."

Apala ͺtchúkla, a peace or white town, was on the west side of Chatahuchi river, and so was Apala ͺtchúkla Old Town, which lay one and a half miles below. On the same side lay Kawita and Kawita Talahassi, but Kasi'hta was on the eastern bank of Chatahuchi river, two and a half miles below Kawita Talahassi, and below Kasi'hta lay "the old Cussetuh town."* The relation in which the Kasi'hta stood to the Kawita people appears, from the terms of the legend, to be that of sister towns separated by segmentation: the legend also suggests that through the influence of Apala ͺtchúkla the immigrants gradually became a white town from the red and bloody town it had been before. In the account of Taskáya Míko, Kasi'hta and Kawita appear as separate tribes from the beginning; they both enjoy the exclusive privilege among the Creek towns to raise the red or scalp-pole; and the high esteem in which they were held is shown by the title of "elder brothers" which the Chicasa and Abika give to them,† though "Kasi ͺta is first in rank." It is singular that one of two tribes which had previously formed *one* town only, became a white or peace town (Kasí ͺta) while the other, Kawita, remained a red or war town, and even stood at the head of the kipáya towns according to a tradition current among the Creeks.

GENERAL RESULTS.

In spite of its legendary character, our Kasi'hta narrative is of value to ethnographic science on account of its high antiquity and of the historic conclusions which may be deduced from it.

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* Cf. i. pp. 133, 134.

† Cf. i pp. 223, 224.

The high antiquity of the legend appears from the circumstance that the tribe appears throughout as one total or a single unit, for the names of the chiefs or leaders have been obliterated by length of time. A chief is mentioned but once, and *without name;* it was when they were advised by him that the red arrows shot back were not a good sign. The constant recurrence of the "sacred" number *four*, the comparative paucity of local names, as well as the lack of any distinct chronologic data about the beginning or end of the migration,—all this testifies to its archaic origin.

The legend in its present form is fragmentary. This appears from the extremely short manner by which the púskita and its origin, the medicinal herbs, and the restless pole, are mentioned, of their importance for the migration can be collected only from the parallel Maskoki legends. On the other side, the stories referring to the "man-eater," the large blue bird, etc., are recounted at full length.

The purpose of Tchikilli's narrative is twofold: 1. It endeavors to report the origin of certain war- and peace-customs, sacrificial acts, and the use of remedial herbs; 2. it attempts to trace the path followed by the immigrating tribe.—Kasí'hta and Kawíta were originally *red towns*, and the customs of a white or peace town (when explained in a similar narrative) would probably have differed entirely from the above. The further back into antiquity these customs could be traced, the more sacred they appeared to the people composing the tribe.

After divesting the Kasí'hta legend of its non-historic and poetic attire, or, to use an expression which is much more to the point, of all the miraculous humbug added to it by later myth-makers and conjurers, the few historic facts forming the foundation of it may be summed up as follows:

The legend does not relate, nor pretend to relate, the migration of all Creek tribes, but only that of the Kasí'hta tribe, from which the Kawita subsequently branched off. Of other Creek tribes only the Ábi'hka is mentioned in the early part of the narrative: after this, Kúsa and Apalaɩtchúkla, which tribes were then established at the same spot where we find them in the eighteenth century.

Another historic fact deducible from the legend is, that the Kasi'hta proceeded from the ancient habitat of the Chicasa people in the northern part of Mississippi state, or from a locality situated in its vicinity.* No passage of *this* legend proves conclusively a crossing of the Mississippi river from west to east, although other legends of the Creek people allude to such an event.

The immigrating tribe evidently followed a trail partly identical with another, known to exist in later times, which crossed the Tallapoosa river at Tukabatchi and the Chatahuchi river near the Yuchi settlement. The existence of a trail like this presupposes a considerable population in the towns connected by it, and, at the time when the Kasi'hta arrived, eastern and central Alabama may have contained as many inhabitants as in the eighteenth century, though perhaps belonging to other nationalities. It is not possible to venture even a guess at these,† nor at the epoch when the immigration of the Kasi'hta took place. The customs of the people as sketched in the legend are about the same as we find them at the beginning of their historic period; and, among primitive nations, customs, habits and beliefs do not change or alter at the same rapid rate as they do with us, because their tribal organization tends to isolate them from other tribes.

The legend originated in and refers to a period of history when the primordial Maskoki tribe had already separated into subdivisions. This appears not only from the various tribes mentioned as being then in existence, but also from the dialects which can be distinguished in the topographic names of the narrative. But still they believed in their common origin; this is, for instance, evidenced by the fact that they had a common belief of having emerged from a mound, hill, or mountain, which the Creeks call 'láni ímmiko, or íkan-hálwi ímmiko, "chief of the mountains," at the present day.

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* That the Kasi'hta tribe were then mixed or intermarried with the Chicasa people cannot, however, be made evident from these indications.

† Dr. Brinton. Ch.-M. Legend, p. 10.

Some reasons which strongly militate in favor of the theory that the tribes of the Maskoki race never crossed the Mississippi river from west to east, are deducible from the phonology and morphology of their languages. These reasons do not prove the fact with the cogency of mathematic deduction, but they are persuasive upon the principle of ethnic analogy.

For the comparison of languages of the Gulf States we have to select only those which appear *indigenous to the country*, as the Timucua, Yuchi, Naktche, Tonica, Shetimasha, Atákapa and Tonkawe, and exclude the intrusive ones, as the Dakotan and Shoshoni dialects (Katába, Biloxi, Kappa, Comanche). The Cheroki is an Iroquois dialect from Northern parts, but was settled in the Apalachian mountains from times immemorial. Now it is a remarkable fact, that the sounds *f* and *‘l* (the palatalized *l*) are found only east of the Lower Mississippi river, in Yuchi, Naktche and the Maskoki languages; Cheroki has at least *‘l*, which alternates there with *tl*, and Timucua has *f*. But west of the Lower Mississippi these two sounds do not occur until we reach New Mexico and the Apache country, which is inhabited by an intrusive people also. On the other side some languages west of that river have the sound *r* and the vocalic *ṛ*, which is not heard to the east of it, except in Timucua. The synopsis of these sounds is as follows:

East—Maskoki dialects: *f*, *‘l*, no *r*.
Yuchi language: *f*, *‘l*, no *r*.
Cheroki language: no *f*, but *‘l*: *r* in *one* dialect.
Naktche language: *f*, *‘l*, no *r*.
Timucua language: *f*, *r*, no *‘l*.

West—Shetimasha language: *f*, *‘l*, *r*, all wanting.
Tonica language: *ṛ* and *r*, no *f* nor *‘l*.
Atákapa language: *‘l*, no *f* nor *r*.
Caddo and other Pani dialects: *r* or *ṛ*, but no *f* nor *‘l*.
Tonkawe language: *ṛ*, no *f* nor *‘l*.
Comecrudo language: *f*, *‘l*, *r*, all wanting.

The most striking feature of this table is the presence of *f* and *‘l*, the absence of *r* east of the Mississippi river, and the presence of *r* or *ṛ* coupled with the absence of *f* and *‘l* in the majority of languages west of it. That mighty river was well adapted to form a limit between nations strangers to each other. As to the Tonica people, it must be added that they dwelt on both sides of the river, and we do not know the site of its original habitat.

The phonetics of Naktche, Yuchi and Maskoki are similar in other respects: in the frequency of nasalization (cf. Cha'hta), in the grouping of certain sounds, in the alveolar pronunciation of the guttural *k*. With no other family have the Creek Indians so many vocables in common as with the Yuchi, whose pristine homes were on both sides of the Savannah river. This also testifies to a very long sojourn of both nations in adjoining tracts of land; the Yuchi have no tradition or recollection of ever having changed their abode, except in recent times. No area of territory can be found west of the Mississippi, the geographic names of which could lead us to assume that tribes of Maskoki lineage had ever resided there, except a few spots on the western *bank* of the Lower Mississippi, which Cha'hta Indians have occupied or *named* since A.D. 1700.

One of the most ancient features of an Indian language is reduplication for inflectional purposes. In this we observe a thorough difference between Maskoki and the languages west of the Mississippi river: in Maskoki, the second syllable is the reduplicated one in adjectives and verbs; west of the river, at least in Tonica, Atákapa, and Tonkawe, it is the first one. Linguists able to appreciate this circumstance fully, will not deny that it is of great weight in separating certain classes of linguistic families from each other, and consequently to assign them different areas in primordial epochs. The Sahaptin and the Dakotan excepted, no other linguistic family of North America is known to me which reduplicates for inflectional (not for derivational) purposes in the same manner as Maskoki.

DIRECTIONS FOR THE USE OF THE TWO GLOSSARIES.

The two Indian retranslations follow the English text pretty closely. to speak generally; but in some passages, where an accurate version was difficult to attain, the retranslations are merely paraphrasing the English original and use circumscriptive language.

As to the alphabetic order observed in the glossaries, it should be remembered that terms beginning with *y*– were placed right after those with initial *i*–, those with initial *'l*– after those in *l*–, those with initial *tch*–, *ts*– after those in *t*–.

In order to recapitulate the important alternations or spontaneous permutations of sounds. the knowledge of which is absolutely necessary for finding the words of the texts in the glossaries, I repeat that *äi*. *ä* alternate with *e* and *a* and vice-versâ; *i* with *î*, *y*, *iy*–, *yi* and sometimes with *e*; *o* with *u*, *û*. As to the consonants, *d* interchanges with *t*; *g* with *k*, *kk*, ; *b* with *p*; *dsh* with *ds*, *tch*, *ts*; *s* with *sh*, and *'l*, but in a few instances only, with *l*. Gemination is frequent with *some* consonants only, as *g*, *k*, *l*, *s*, *m*, *n* in míkko, itállua, adsúlli, púmmiki, issi- (prefix) etc.; when occurring in vowels, it marks emphasis: tchá-ati *red*; *h* is often dropped: hadám and adám, ok'huláti and okuláti; often it is inserted for emphasis: ito-ú'h; and still more frequently it marks in Creek a preterit tense: í'hsäs (from ísäs) *I took*; cf. vol. i. 205.

Nouns are entered in the glossaries under the forms of their absolute cases; the subjective case ends in -*t* (-*d*), the objective in –*n*. Adverbs usually have the case-endings –*t* or –*n*. When a Creek Indian quotes a verb, he usually gives it in the infinitive mode ending in –*ita*. I have substituted to this form the first person singular of the present, declarative mode of the active voice in –*a-is*, contr. –*äs*, because a large number of substantives also end in -*ita*, which might cause confusion. The impersonal verbs, of course, were quoted in the third person in -*is*, -*īs*. The numerous verbals also end in -*t*, –*n* in the cases above mentioned. The numerous forms ending in *-atis*, *-katis* all belong to the historic past or aorist tense; cf. vol. i. 206.

Many of the suffixes were separated from the body of the word by the simple hyphen, especially when polysyllabic: *-tati*, *-titá-yis*, etc.; but the shorter ones were not, as in Creek: *-äs*, *-ga*, *-ha*, *-it* (*-in*), *-sin*, *-tun*, *-u*, and others. They are, however, mentioned in the glossary.

When two vowels meet belonging to two words forming a compound, or belonging to two affixes forming a derivative, the vowel of the first word, not that of the second, is elided; e.g. ádsh'=imápi *stalk of maize*, not ádshi=mápi.

The parts or limbs of the human and animal body and the terms of relationship appear in the Maskoki dialects always connected with *prefixed* possessive pronouns. I have therefore entered most of them in the two glossaries under *im-*, *in-*, *i-*, the possessive prefix of the third person.

The other nouns and also the verbs of the Indian texts beginning with *im-*, *imm-*, *in-*, *inn-*, *i-*, or other prefixed personal pronouns, as *tcha-*, *an-*, *tchi-*, are to be looked for under their simple forms in Creek; inló꞉adis under ló꞉äs, inkákida under kákida, póf'igi under ífigi. In Hitchiti: ímmiki under míki.

In many verbs the personal or possessive pronoun is *inseparable* from them, and such verbs as these will be found either under *an-* (1st pers.), *i-*, *im-*, *in-* (3d pers.), or under *tcha-* (1st pers.)

For further elucidation of the grammatic forms in the Creek and Hitchiti text, cf. the morphologic sketch of the Creek language in vol. i. pp. 198–211, and that of the Hitchiti language in vol. i. pp. 80–85. Some Creek terms quoted in vol. i. were entered in the Creek glossary, others will be mentioned in the *Index*.*

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* The Creek text appears in this volume in a revised and correct shape, and parties owning the first volume should therefore remove pp. 237-251 before sending it to the binder. In violation of our contract, the publisher D. G. Brinton undertook to "correct" the Creek text himself; the natural consequence was that about one hundred errors were left standing, and the text was rendered totally unfit for scientific use.

THE CREEK GLOSSARY.

a- prefix of verbs and nouns: *from, coming from.*

Ábiχka, pl. Abiχkánagí, nom. pr. *Abika, Obika Indian;* Abiχkánagitawat *but the Abika Indians* 12, 11.

adám, hadám 1) *again;* hadám 14, 33. 2) *or* 12, 26.

adsh-, atch-; a prefix commonly placed before another prefix, as -ak, -uk (-u'h): *behind, in the rear of.*

adshakáyäs, du. of subj. adshakahóyis, pl. adshakapíyis *I am following, going after, going alongside of;* said of objects moving, travelling; also of roads, paths, etc. Nínin adshakapiyakátin atíχgit *to follow the trail into which they had stepped, in which they stood* 12, 36; adshákayigō-titáyin *being unable to follow* 14, 7; adshákkahid *having followed, travelled with* 18, 13. Der. ak-, áyäs.

adshak'hui'läs *I chase, pursue.* adshak'hui' la'lánayatalgid *being bent upon the pursuit of,* p. 60; lit. "having to stand in behind, at a future time"; from adsh-, ak-, huíläs, 'lánaya, tálkis; cf. i. 206, and ak'huíläs.

ádshi *maize, Indian corn;* ádsh'=imápi *maize-stalk,* vol. i. 203. a. intálapi *ear of corn;* a. loátchki *soft corn, green corn;* a. wánhi *hard corn;* a. íssi *leaf, husk of corn;* ádshid=äs *such a thing as corn* 14, 26.

adshuktchákäs *I overtake, catch up with.* adshuktchaχaígin *overtaken by,* as by misfortune; lit. "it having come upon (me)," p. 60. Der. adsh-, uk-, tchákäs *I overtake.*

adsúli, adshulagi-táti; see atsúli.

Afos=afíska, nom. pr. of a stream in the old Creek country, Eastern Alabama: *Bark-peeling Place.* Der. afō'swa, q.v., and afísäs *I peel, strip* (bark, skins, etc.) 14, 35.

afóswa, coll. afō'salgi *switch, flexible branch, underbrush* 14, 10.

afúswa (*u* short) *sewing-thread, thread.*

aháka 1) *law, legal practice;* 2) *custom, habit.* maháka, abbr. from imáhaka; lit. "his, their law, habit"; *common law, custom, habit.*

ahák i *likeness*, *image;* hókti ahákit háhin *making a likeness of a woman* 12, 15. Der. hákäs *I become.*

ahássi *old*, *ancient;* mostly referring to inan. objects. Talua-ahássi, contr. tal-ahássi *waste town*, *village almost deserted*, *abandoned;* a frequent town name, cf. Talisi vol. i. 144. 145.

ahí'lit ō'mīs *it is better*, *preferable;* a. o. kó'hmit *having thought that it is better* 14, 11. Der. hí'li.

ahitídshäs *I kindle*, *set* or *apply fire to;* ahitídshi ísfullatid *they had it lighted with* them 10, 18; ahitídshatit *having lit*, *kindled* 10, 10. Der. ahítkäs; cf. íti, H. glossary.

ahítkäs. pl. of subj. ahít'hukäs *I burn*, *I am consumed by fire;* 'láni ahítki ō'dshi *that was burning there on the mountain* 10, 18 (verbal); ahítki, pl. ahít'huki *burning*, *blazing* 14, 14 (partic.)

ahítchkäs, anhítchkäs *I acquire*, *obtain*, *get possession of;* ínhītchkin *obtaining*, *having obtained* 10, 11. imáhilissua inhitchékadi, inhítchkadi *ever since they obtained the medicines* 10, 30. 33. anhī'tchkäs *I have obtained*. inhítchkadīs *they found*, *obtained* for themselves 10, 27. Der. hídshäs; cf. hítchkuidshäs.

ahopáka 1) *emblem*, *symbol*, *sign.* ahopákat ómis *is the symbol of* 12, 28; cf. 16, 34. 2) *measuring instrument; rule*, *compass*, *yard-stick*, etc. 3) *object measured.*

ahopánäs, pl. of obj. ahupanhuídshäs *I spoil*, *destroy;* imahupánid ómika *they would spoil on that account* the power of the medicine (im- what belongs to others) 10, 37. ahupā'näs (pret.) *I have spoiled.*

ahóskäs *I remain over*, *am left over;* ahō'skadin *those left over*, *the survivors* 16, 27.

ahudshífäs *I name after;* ahudshífît umhóyadīs *it was named thus after*, *from* 14, 32; cf. hodshífka *name.*

ahupu'llínäs, pl. of obj. ahupu'llinákäs *I acquire a knowledge of*, *learn about* 10, 12; cf. hopóyäs.

ahusitchä'tchäs (s. & pl. of obj.) *I reserve*, *preserve* 16, 26.

áyat 1) *travelling*, *going;* verbal of áyäs, q.v.; 2) *since*, *since then;* lit. "timegoing," 10, 33. háyumi ayat *since;* lit. "from now going on."

áyäs, dual of subj. ahóyīs, pl. apîyīs, apí-is *I go, march, journey, travel, move, proceed;* apíyit (verbal) *starting, marching;* occurs often, as in mó'hmit apíyit *hereupon journeying onward* 8, 27; apíyid ómatis *they are starting* 14, 20; apiyat hátchî *coming to a river* 14, 24; apíyatäs better apíyat'täs, from apíyatit-äs *whenever they go* 10, 23 (-äs suffix, q. v.); hadám apíyad *starting again* 14, 33.— Apiagî'l or apíyagī'l! *let us go!* (-ī'l archaic suffix for -īs, from the so-called female dialect) 12, 4; apíyatīs *they journeyed* 8, 26; cf. 10, 1. — Apíyis *when they start* is construed with the subjective case of the indirect object: hú'lidäs *for war* 12, 26; and hó'litäs apia'lánit *when they are about to start for warfare* (-'lánäs, suffix of one of the future tenses) 14, 19.

ayídshädshäs 1) *I continue, proceed further;* u'h'láni ayídshädshad they were *continuing to cover* 12, 11. 2) *I make, cause to go,* anim. or inan. obj.; in this definition the dual is ahóyidshädshäs, the plur. apiyídshädshäs. Der. áyäs.

ayíktchäs, pl. of subj. ayíktchīs, pl. of obj. ayíktchagäs *I hold forcibly, I hold fast, cling to.* ayíktchi imúnkatis *they continued to cling to* 16, 37. Der. yíktchi.

ak-, prefix: *into* or *in the water,* or into a hollow, a deep chasm, a valley; *down into.* Originally referred to water only; probably from radix of óki *water;* cf. ú-i-ákfusua, under fúsuă.

akadápkäs, du. ak'hatap'hókis, pl. ak'hatapídshīs, ak'hadap'hídshīs *I go down, descend,* v. intr. This refers to the descent towards the water over the *high banks* between which southern rivers are flowing. o-i'lákun akadápkid ō'min *leading down into the river;* lit. "descending being" 16, 7. ak'hadapídshatis *they descended* 12, 38.

akasámäs 1) *I believe, add faith to;* akasamā'gid óměka *having believed it on that account;* viz. on account of Tomochichi's personal visit to Great Britain; 18, 14. 2) *I praise, extol.*

akasámka 1) *belief;* 2) *praise.*

akělátka, see aklátka.

ak'huiläs. ak'húi·läs, du. aksihógis, pl. aksapáklīs *I stand inside of, down in* something. Der. huiläs; cf. u͐huiläs.

aki·läitchka 1) *mind, thinking power, intention;* imagi·läítska *their mind, intentions* 16. 32. 2) *remembrance, memory of:* isagi'létchka *remembrance of* 14, 19. Der. kí·lädshäs, vol. i. 211, from kí'läs.

aki·létchäs, agi·läídshäs 1) *I remember, I think;* 2) *I think of.* cf. i. 186; cf. ki'lä'dshäs i. 211.

aklátgäs, a͐látkäs. pl. of subj. akpalátkīs 1) *I fall, tumble into.* 2) *I go down, set:* said of celestial bodies: hă'si aklátgīs *the sun, moon is setting;* hă'si= aklatgátin *in the west* 8, 18; cf. aklátka. hă'si a͐látkita hitchita hí·lit ōs *it is pleasant to see the sun set.* Der. ak-, látgäs.

aklátka *west:* akĕlátka 10, 15; in-hás=a͐látkosin *west from there* 8, 22 (-usi suffix); hă'si= (or hás'=) aklatgátin *at the sunset, in the west* 8, 18, is a verbal of aklátgäs, q.v.

akmágäs, akmákäs *I speak to, command* while being *down* in some place. innákmagäs *I speak for the others, command for them* 10, 39. Der. mágäs.

akpalátīs. see akweíkäs.

aksumídshäs, pl. of obj. aksumidshä'-idshäs *I cause to sink into, to be lost in, to be covered over* by earth, water, &c. aksomidshä'͐tchin (pl. form) "they lost it" *by causing the sinking in, disappearance of.* 12, 8.

aktchíyäs, du. aktchihúyīs, pl. aktchíyīs, *I go down into,* as into water, a thicket, canebrake, &c.

akuyí'htchit, see akwíkäs.

akweíkäs, pl. akpalátäs *I throw down into;* úyuan akweíkīs *we throw into the water;* tchádun (ó-iwan) úyuan akpalátit *throwing many stones into the water* 16, 24. Der. waíkäs.

akwíkäs, du. akwihókis, pl. akuyídshīs, v. intr. *I remove, migrate;* akúyi'htchit apó͐adīs *having removed they settled down* 8, 22.

alákäs, alágäs, alá͐äs, du. alahókis, pl. yédshīs, yé-idshīs, yaítchīs; 1) *I approach, come, arrive.* cf. i'lalákäs *I return from.* níta umálgan alágit *coming every day* 12, 14. tútka immalákatis *a fire approached them* 10, 13. 14. 16. 17. 2) *to occur, happen,* said of events.

alakúidshäs *to bring, carry;* imalakuídshi *one who brings to* somebody. Der. alákäs.

álgi, -algi 1) *all, entire, whole;* hátkusi (or hátkati) álgid ómatis *it was wholly white* 12, 32. 2) *abounding in:* tchadû-álgi *rocky, full of rocks* 12, 38. 3) suffixed to nouns, -algi forms collectives: Yútchalgi *the Yutchi people;* Maskokálgi *the Creek nation;* afō'salgi *thicket of underbrush* 14, 10; corresponds in tribal names to ókla of Cha'hta. Derivatives are: omálga, q.v., súlgi.

álgin *everywhere* 16, 13.

Alibámu, pl. and coll. Alibámalgi, nom. pr. *Alibamu Indian;* they once were settled on Alabama river, Ala., at and below the confluence of Coosa and Tallapoosa rivers, and belonged politically to the Upper Creeks. In text we have Atilámalgi 12, 10; see note in Commentary.

aligápäs *I glitter, flash, am resplendent* 10, 5; said of fire, mirrors, etc.

alíktcha, alíg'tcha. coll. alíktchalgi *medical practitioner, doctor,* Indian or white; alíktchäs *I am doctoring, treating;* cf. hílissua, hilis'-háya.

á'läs, du. wilágis, pl. fúllis, fóllis *I am there; I am about, present;* generally connected with the idea of motion, moving about, but sometimes used like a mere auxiliary verb forming periphrastic conjugational forms. Fû'suă á'latis *a bird was about* 12, 13. 15; hía fû'suă á'latin *this bird being* or *hovering about* 12, 16.; húma-wilákad *two going before, in front* 16, 19; fúllis mómof *then* (they) *will be going about* 12, 27; wákat fúllis *cattle moves about;* fúllid ómis *they are moving* 14, 21. 16, 19; pohágit fûllid ómis *they are hearing it* 16, 13; apíyit fúllăti *when they were marching* 16, 18: fúllin ómofa *when they are engaged* (in war) 16, 12; fúllangid ō'mis *those who had been there* making the white path 14, 38: (-angis, suffix of a tense long past; cf. isiyángis vol. i. 206;) ístit fúlli-hí'lit ómadin *that people certainly had been there* 12, 33 (cf. hí'li).

a'lkasatúlga *drum* 16, 10; from á'lkasua, sort of *jar* with narrow opening, and atulpúyäs *I wrap up.* The usual term for drum is now tamamápka.

amititágîs *I am ready, prepared.*

anáfkäs, pl. of subj. anafhúgis, anafhógis, *I strike against.* Der. a-, náfkäs.

anákî *near, close to.*

anákuasin, prep. & postp. *very near by, close to* 8, 20. 12, 34. Der. anákî, -sin.

ánäkuidshas *I approach close to.* Der. anáki; cf. tímpuidshäs.

ánhahi, p. 60; see háyäs.

anhitchki=hí'lis *I have good luck, am fortunate;* lit. "my opportunity or capacity of obtaining is good." ihitski=hí'lis *he has good luck.* ihítski=hí'lin fúllid ómis *they journey about with good luck to them* 14, 21. Der. ahítchkäs, hí'li.

áni, ánit, ánin, abbr. an-, a-, *I, myself.* ánit ō'mäs *that is mine; I do it, I am the cause of it;* cf. i. 203. 209.

án'lawa, ánla'wan 1) *away from houses, lodges, settlements; in the woods, outdoors.* 2) *outside of; contrary to.*

Antitchi, nom. pr. of a headchief of the Kawita tribe 8, 8.

anukídsha, nukídsha *lover.*

anukídshäs *I love;* cf. i. 14.

anukítska *love.*

a-óssäs, a-úsäs, du. of subj. awúlgis, a-úlgis; pl. asóssīs, asósīs. *I issue, come out, emerge from;* a-osä'-iyit *issuing, rushing forth* 14, 10. ā'sosa-id *having come out of* 8, 20. Der. a-, óssäs; cf. asóssäs.

apa-idshídshäs *I follow* something spread out, extended. úyuan a. *I follow the water-course* 16, 14.

apaígäs. pl. of subj. atíhis, atíkīs *I stand, go, move, am within, in, inside of.* man (nī'nîn) atihäígit *stepping into it* (the path) 12, 37. ma nī'nîn atí₁git (preterit) *having stood in that path* or *trail* 12, 36. isti talófa ati₁kad *those who stayed in the town* 16, 21.

apákäs *I accompany, go with* somebody. apákin (verbal) *having come with him* 8, 16. It stands here for the word *other* of the English translation. ín'li apákīn ō'dshit ómatis *had arrows with him;* lit. "was having its arrows going with him" 12, 21. 22; cf. itipákäs.

apála'h, apála 1) *across, on the other side of,* now more frequently used in the form of tapála (iti-apála), q.v.; cf.

apálua. pal-hámgin. 2) *above, higher than;* seldom used in this sense, cf. hátch-apála'h: "up towards" is expressed by a'líba fátsan.

Apala'htsuklálgi 8, 10; same as Pala'htchuklálgi; see Pala'htchúkla.

apalátäs cf. aweíkäs, q.v.

apálua, apállua *a part, a portion of* S, 22; *the rest, remainder.* apáluat apóki sásatis *a portion settled down* 18, 3; cf. apála'h.

ápi (*a* short) 1) *stem, stalk, trunk of tree;* 2) *pole, handle* adsh-imápi *maize-stalk.* Occurs also in tálapi *cob, ear;* Nófāpi nom. pr., púkabi, etc.

apíyatäs, apíyis, apia'lánit, etc.; cf. áyäs.

apingalídshäs, pl. of obj. apingalakuídshäs; pret. apingalakuí'htchäs *I scare off, take away by frightening.*

apókīs, pl. of läíkäs, q.v.

apókita *village; settlement* of one tribe, *group, cluster; habitation* of a body of persons. apopókita *settlements* of *many* groups or tribes. Der. apókīs; cf. läíkita, kákida.

á'sa, pron. dem. *you, yonder, that one* over there; refers to objects seen at a distance. isti ása huí'lat *that man standing out there;* ása-táti *that yonder first.*

asítch'häs *I shoot back, I shoot in return with* 16, 21. Der ítch'häs.

asóssäs 1) *I bring out, make come out;* pret. asosáyäs *I have brought out.* 2) asóssis, when intrans. as in S, 20 is from a-óssäs, q.v.

ássi 1) *hair;* íssi *his, her hair.* 2) *leaf,* viz. "hair of plant"; archaic form û'ssi. 3) *black drink,* an exhilarating beverage made of the leaves of Ilex cassine, a kind of haw, and in use among all Indian tribes of the Southern States. The tree is a species of evergreen, leaves ½ to 1 inch long; it is called in Creek sometimes ássi lupútski (tree of) *small leaves,* but more frequently ássi *leaves* 16, 33; cf. tsútki.

ássitchäs, pl. of subj. ássidshīs *I pursue, hunt, follow up, chase.* ássitchatis *pursued* them 14, 10. ássitchi *while pursuing, when following up,* 16, 26.

ā'ta, ā'da *below, in lower part of.* hátchi imā'ta *down stream;* cf. hatcháta.

átassa, átäsa bent piece of wood used as a *war-club*, not a tomahawk as in the text. A word borrowed from the Cheroki language, where it is pronounced átsa and tá'hsi 10, 24.

atáss-aháki *pole* painted with *red clay*, six to seven feet long, cut to a peculiar shape and slanting towards the centre of the busk-square. Certain towns, like Okfúski, had three or four of these before each shed or gallery. Lit. "war-club made alike."

átäs, du. at'hóyīs, at'hó-īs, pl. áwīs *I come*. átit immalákatis *while coming it approached them* 10, 13. át ófan *when coming, at the time he, they came;* for áti ófan 14, 13; cf. i'lá-awid 10, 35 (under i'lá-atäs).

atíkat, atígat 1) *every part of, the whole of; all of the kind.* ísti huílat atígat *every person* ("standing"); lóktsat atígat *everything ripe* 10, 32. 2) *ever since;* mú'hmati atígad *ever since that time* 18, 1; *up to now, up to this day.* Der. átäs.

atíki, atígi, postpos., *up to, so high, so far as, that far;* inúkua atígin ak'húi'l *he stands in the water to the neck;* atígīn *along the border, edge of;* atíkusi *so as to reach;* cf. -usi; atíkusi-táyin *just enough to reach* (the knee) 12, 12. háyomi atíkäs *even* (-äs) *up to the present time* 10, 19. Der. átäs.

atíχgīs, pret. pl. of apaígäs, q.v.

atchakapiyakátin, see adshakáyäs.

atchikílläs *I step, go backwards; I retrace my steps.*

atsuläídshi *old, elderly;* adsuleídshi-tût for being *the oldest, most ancient;* stands here for *bravest*, most respected; -tut a causal particle 10, 38.

atsúlga *age* of man, animals, inan. objects; cf. atsúli.

atsúli, pl. atsúlagî 1) adj. *old, aged;* 2) subst. *ancestor, forefather;* adshulagi-táti *the old people that were; the defunct ancestors* 8, 1.

awaihígäs *I am next in order;* awaíhīgadīs *they came next* 12, 10.

awaikäs, aweíkäs, pl. apalátäs, *I throw away.* i-aweíkäs, see yaweíkäs. imawaigákatis *they threw it to, for, before him* 14, 12. Der. waíkäs; cf. akweíkäs.

áwīs, pl. of á·äs, q v.

awoläídshäs *I approach;* awoläídshit *approaching, when he approached* 14, 12. awolä'dshit *approaching* 12, 29. yáfgi awuläídshīs *evening is coming on.*

-äs, -es, -ēs, suffixed: 1) *or, either, or else.* tsulákutäs, wákatäs, súk'hatäs *horses, cattle, or hogs.* hó'litäs 14, 19. 16, 12. istamaítäs 16, 13. 2) *such, such as; even; for instance.* konawátäs *even beads.* ho'lkópitäs *stealing for instance.* 'lá'lotäs *such things as fish* 8, 30. atíkäs 10, 19; see atíki.

emúngatis; see imúngīs.

fáka *cable, rope, string; vine.* itcha-kuadáksi îfáka *the bow-string,* lit. "of the crooked gun its string" 12, 23.

fáki, fággi *dirt, mud, clay, earthy matter.* fáki tchádin *with red clay* or *red paint* 12, 2. To paint themselves red, the Creek Indians now buy Chinese vermilion (sulphurate of mercury or cinnabar) at their traders' stores.

faläpkäs, pl. of obj. falá'hlidshäs *I split,* as wood, bulky objects, etc. faläpki *what is split;* cf. tukáχlidshäs.

fátcha 1) *straight, going in a straight direction.* 2) *right, correct.*

fátchan, fádsan *in a straight direction; towards.* hási-óssāti, hasóssa f. *towards sunrise, east* 8, 26. 14, 1. homá-fátcha *toward the front;* yebófatcha, yupó-fatchan *toward the rear.* iyúksa fádsan *toward the end of* 8, 32. imfá-dsan *right in the direction of.* 2) when points of the compass are spoken of, f. often means *from the direction of:* hă'si-óssati f. *from the east* 10, 13; wahála f. *from the south* 10, 14; akĕlátka f. 10, 15 *from the west, sunset* 10, 15; huní'la f. *from the north* 10, 17.

figábäs *I rest, take a rest.* fígabin u'hhayátgadis *it dawned over them when they rested* 8, 28.

fik'hí'lki, adj. *quiet, tranquil, at rest;* lit. "with peace in heart." Der. ífîgi, hí'lka.

fik'hí'lkîgu *restless, troubled* 10, 20. Der. fik'hí'lki, -ku.

fik'húnnäs 1) *I remain, stay; I stop, cease.* mátawan fik'-hunnin *remaining at the same place* 14, 18. í-upan fik'-húnnatis *remained behind the others* 8, 24; the proper form for the plural would be fik'hunnákatis. 2) *I remain* *quiet, undisturbed;* fik'húnnis *it is quieted* 10, 22; cf. mágäs. Der. ífiki *somebody's heart*, húnnis *becomes heavy*. The explanation is that people with sorrowing hearts will remain quiet and not stir about.

fóyäs, fóya-is *I am sawing.* ítun fóyäs *I saw timber, wood.* ítu=isfúχa 'láko *cross-cut saw;* (i)tu=fúχa *sawed timber;* cf. kítäs.

fúllangīd, fúllis, fulli=hí'lit ómadin; cf. á'läs.

fullidshä'dshäs, pl. of obj. fúlhuidshäs *I return, give back.*

fúsuä *bird;* fus=hádshi *bird's tail*, u-í=ákfusua *water-birds:* ducks, geese, herons, etc.

-ga, -ka (-in:-uga, -oka, -iga and other forms), causal suffix appended to nouns and verbs, and abbreviated from -gáχ-kan: ō'stîga *because there are* (or *were*) *four* 12, 1; isi-gáχkan, abbrev. ísiga *because he takes* or *took* i. p. 207; ómiga *as, since, because, on account of;* tchátidûga *as they are red* 16, 4; kómākikika *as they thought* 8, 24; ikó-si-ga *as it is smoking.*

-go, -gu, -gū privative suffix; cf. -ku.

-ha, -a, suffixed; serves as interrogative particle: "may it not be so?" cf. -titáyīs, in 10, 39.

hádshî *tail* 12, 27; ihádshî *its tail* 12, 13.

hági, hágita, hákita *noise, sound, clatter.* hía inhági *this its sound, this noise from it* 16, 13; cf. watúla. Der. hákäs *I make a noise.*

háhit, see háyäs.

hayayálgi, the four genii who brought fire from the four cardinal points to the ancestors of the Kasi'hta tribe, according to the legend related by Taskáya Míko, in vol. i. 222, sq. The term is connected with Cr. hayáyagi *light, radiance*, and is referred to in Commentary under Color Symbolism, &c. These genii are what other Indian myths call the four pillars of the Sky.

hayátgî 1) *daybreak, dawn* 8, 28; 2) *morning, day* 14, 34. 36; cf. nódshäs, u'hhayátgäs. Der. háyäs, hátki.

háyäs, pl. of obj. háhi-äs *I make, construct, manufacture;* hápu hayäs *I strike camp, encamp* 8, 28. hú'li háyäs *I make war, I am on the warpath;* inkákida háyatis *they* *made their settlement, they settled down* 8, 20. háhi-it *having made* (plur.) 14, 38. háhit, contr. from háhyit, háhi-it *making, having made* 12, 15. háhid *manufactured* 14, 8. níni hátki háyi *those who made the white path* 14, 37. háheidshit, for há'hyidshit, *having made* (bows) 14, 27. inhayákatin *made, constructed for him by them* 14, 13. Passive form: inhahóyadi *made for him, her, it* 12, 16 (verbal). ánhahi *made for me*, p. 60.

hayómi *just now, at present; just then.* This adverb appears under various case-forms: hayúmat, hayómad, ayómat, hayómit, hayúm-äs. Hayómi atíkäs *even to the present time* 10, 19; almost equivalent to hayómäs (ayúmēs) *up to this day* 10, 7. 14, 15. hayómit *at that time* 10, 29. Der. hía, i-ómat.

hákäs, háχäs, pl. of subj. hahókäs 1) *I cry, shout, make a noise.* hákid ómis *it makes a noise like that* 16, 11; cf. óki. lámhi ókin hákin ómat *if he cries like an eagle;* lit. "if he is crying alike in voice to an eagle" 12, 30. háhokadin *because whooping, crying* 14, 32. 2) *I chatter, caw, whoop:* said of birds,

hákäs *I become, begin to be, turn into.* hakitáyid ómika *therefore they would become* 10, 37. tchahákit *I become;* tchahákitûka *because I would become so.* hítchgigō háχadīs *it became invisible* 12, 8. hí'lka hákadäs *when peace is being made* 12, 26. cf. hákin.

hákin *then, at that time*, lit. "when it happened." hofóni hákin, or hofóni há'hkufan *a long time after;* lit. "after a long time had been completed" 12, 18. hákit ōs, hákitûs *now*, as opposed to "formerly." Der. hákäs *I become*: cf. hofónin.

hállui, pl. halháwi, adj. *high, tall.* 'láni hálluit läíkin *at a high mountain lying* there 14, 36. Observe the juxtaposition of a subjective and an objective case in the same phrase forming *one* object; 'láni hálluin läíkin would be incorrect.

hálluin, hálwi, hállui; adv. *upwards, skywards* 10, 5.

há'lpi 1) *skin; tanned skin.* yánas'=há'lpi *buffalo-skin* 8, 6. 2) *bark;* údshi=há'lpi *hickory-bark* 14, 6.

hámgi, subj. hámgit, obj. hámgin, hámkin. 1) adj. num. *one*. apóki hámgad (for pála=hámgad) *those settled on one side* (of river) 18, 4. nĭ'ta hámguf *after the lapse of one day*. nĭ'ta hámgad *in a single day* S, 29. In counting objects, hámmai is in use; hamgákin and hamgahákin *one to each*, cf. i. 202; hamháyosi *one here and one there* i. 203. 2) *other*, *another:* hátchi hámgin *another stream* 14, 35.

hámgusi, hámkusi, adj. *only one*. hámgûsid ómis *is only one*, *is unified* 18, 5. pû'mmikut hámgushikas *let our chiefs be one; let us have one chief only* 18, 1. hámkusit *only one* person 14, 11. Der. hámgi, -usi.

hammági for hán mági *saying so*, *saying this*. hammáki. opunáyatis *he related in the following words* S, 3. Dert hía, mágäs.

hápu, hábu! 1) *site*, *location of*, as location of the bullet in a wound, or *site*, *area* of house, plantation; *field* allotted to certain crops. 2) *camp;* permanent or transitory *encampment;* hápu háyäs *I strike camp*, *I encamp* S, 28.

hasatídshäs, pl. of obj. hasat'hä'-idshäs, *I wipe off*, *cleanse*.

hási (*a* short), hássi, 1) *sun;* hási=óssati *in the east* S, 26, etc. hă'si=aklatgátin *at the sunset; in the west* S, 18. 2) *moon*. 3) *lunation*, *month*.

hássi, abbr. from ahássi, q.v.

hat'hē'dshaksh 16, 36; see hatídshäs.

hatídshäs, pl. of obj. hat'hä'dshäs, pl. of subj. hatídshis *I whiten*, *make* or *paint white;* idshû'kuan hatídshit *having whitened his mouth* 12, 29. hat'hē'dshaksh! for hat'-hē'dshatchkis! *whiten ye* (your bodies)! 16, 36; cf. hátki.

hatitchíska *first;* ihatitchíska *the first of it*, *its beginning* 10, 27.

hátki, hátgi, pl. and distr. hát'hagi *white* 16, 27. táf=atki *white feather* 16, 39; from táfa hátki. u-i=hátki *ocean*, lit. "white water." hay=átgi *daybreak*.

hátkusi, pl. hat'hákusi *wholly*, or *very white;* hátkusi-álgi *quite white around*, *in many spots* 12, 32. 33. Der. hátki, -usi.

hatchapála, hatch=apála'h *up the river*, *up stream*. ísti Maskóki Hatchapála'h *the Upper Creeks* S, 2. 7. 18, 6. Der. hátchi, apála'h.

hatcháta, hátch=áta *down the river, down stream.* ísti Maskō'ki Hatcháta *the Lower Creeks* 8, 2. 7. 18, 6. Der. hátchi, ā'ta.

haúkäs, pl. of subj. hauhákīs *I am hollow, concave.*

haúki, haóki, ha-úki, pl. hauháki, adj. *hollow; ítu haúki hollow tree.* tchátu haúki *hollow rock, cave, cavern* 14, 3. íkan=haúki *a hollow, cavity, hole, pitfall* 14, 12. 13.

hawáχläs, pl. hawalkákis *I open;* said of the mouth only: 8, 19, where it is used intransitively. Der. haúki.

hía, ía, i-a, ya *this, this one.* hía läíkat *this thing, object* (sitting) *here.* í-ama, yáma *here.* hia-ú *this one too.* í-a 'láni *this mountain* 10, 6; cf. ă'sa, ma.

hían, *here, at this place* 14, 2.

hiátawan *here also, at the same spot* or *place* 10, 26; from hían, táwa.

hidshä'dshäs *I show, exhibit.* hidshédshaχadin (verbal 3 p. pl.) mákatis *he said* to them *when they showed* him (the arrows) 16, 2. Der. hídshäs.

hídshäs, hítchäs, pl. of obj. hídshakäs 1) *I see, behold, perceive, find out.* illídshida kómid hídshi-is *we will see and endeavor to kill him* 14, 5; hídshatis *they perceived* 10, 2. hidshákatis *they perceived, found out* 10, 6. hidsháχatis *they saw* 16, 7. í'htchit, for hí'htchit *having seen* (a smoke) 16, 29. hídshatit ómit *for having seen* 18, 8. hí'htchagīs *that we should see* 10, 4; lit. "suppose we see what it is; let us see what it is." tchahidshóhis *I am seen;* cf. also i. 231, and yihídshäs. 2) *to find, discover;* hidshída kómi *desiring to find* 16, 29.

hídshi *tobacco.* Cf. i. 58.

ki'läídshäs *I show kindness to, attend closely; I do my duty towards.* impunä-ípat hí'läidshä-it *I am speaking with reverence, with dutiful feelings,* p. 60. Der. hí'li.

hilis='háya, coll. hilis'=háyalgi *medical practitioner.* Der. hílissua, háyäs.

hilis'=háyäs *I prepare, make a remedy.* Der. hílissua, háyäs; cf. alíktchas.

hílissua *medicine, remedy,* spiritual and material. imáhilissua *somebody's medicine,* invented by him or them 10, 11.

30. The term inhílissua, a remedy for certain diseases, is not in use.

hi·lé-idshäs *I put away, remove;* referring to corpses, to provisions buried for future use, etc.

hí'li, pl. hí·lagi 1) *good, excellent, useful; pleasant, agreeable.* hí·lit=wē'tis *probably the best; may be best* 8, 24. ísti hi'lágit ómin ómad *if the people were good* (or not good) 14, 39. 2) Is often incorporated with other words, and then forms verbs or verbal phrases with an asseverative or augmentative meaning: fúlli=hí·lit ómadin 12, 33; anhítchki=hí'līs, q.v.

hi'lígäs, hi'líkäs *I am satisfied with, it suits me.* inhi'lagigádīs *they were dissatisfied with them* 8, 32. Der. hí'li.

hí'liko, pl. hí·lagiko *not good; bad, wretched, unsatisfactory, disagreeable.* hí·likut ōs *it is not good so* 16, 2. inhí'lagikun *unpleasant to them* 8, 31. inhí'lîkut *not satisfied, not feeling well;* lit. "not good to him, them" 8, 25. Der. hí·li, -ku, privative particle.

hí·lka *peace;* hí·lkan háyäs *I make peace* 12, 26. Der. hí·li.

hí·lkayīs, hi·lká-is, hí·lkäs *I make, conclude peace.* hí·lkida isahopákan *as a sign of friendly behavior, of a peaceable mind* 16, 33. ístit inhi·lka-is *I conclude peace with him, them.* This verb occurs but seldom without the pronoun prefixed.

hí'lkusäs *I am quite peaceable, I am very well-minded;* mági hí'lkusa'li kómait *desiring to be of very peaceful intentions in everything*, p 60. Der. hí'lkusi *very peaceable*, from hí'lka, -usi.

híniha Creek war-title, which originally was a busk-title referring to the preparing of medicines. Among the Timucua the inihama were *tribal councilmen, headmen;* the Creeks perhaps borrowed the term from them; cf. i. 157.

híshi lopútski *little tobacco* 10, 29; also called hídshi pákpagi, cf. pákpagi. In this connection tchútki, the sing. of lopútski, is not in use.

hítchgigō, pl. hítchgagigō and hítch'hukikō *invisible, unseen, no longer perceptible* 12, 8. Der. hídshäs, -gō (-kō).

hítchkäs, pl. of subj. hitchkákis, 1) *I appear.* 2) *I am born;* also tchahítchkīs. hí'tchkatis *was born, came forth* 12, 19. Der. hídshäs.

hítchki=hí'lis, cf. anhítchki=hí'lis.

hitchkuídshäs 1) *I bring forth, give birth to one offspring.* hítchkuidshi wäitis *might probably bring forth* 12, 18. 2) *I gain, win, obtain; I acquire, get possession of.* hupuitági ihitchkuídshit *obtaining for their children* 16, 3. Der. hítchkäs.

hodshífäs, pl. of obj. hudshif'huyídshäs *I name, I give a name, I call by name.* hodshifhóyigō *not naming, not mentioning.* kaítchîd hodshífatis *they named it by calling it so* 10, 6; cf. 14, 34; kaítchid is here superfluous. Cf. ka-ídshäs.

hodshífka, pl. hudshíf'huga *appellation, name.* The plural has a distributive function.

hofónin, hofónen *for a long time* 12, 17; often connected with hákin, q.v. (hofóni hákin).

hokólin, abbr. hóko, *two* hokóli-algi *two to each.* hokólusi, hokólĕsĕn *only two, but two* 16, 26. 27. (-usi suffix.)

hókti, húkti, pl. hóktagi 1) *woman, female* 10, 33. 37. 12, 15. 2) *female animal:* fa=húkti *bitch.* Cf. tchukuläídshi.

hóma, 1) adj. *what comes first, is nearest, is in front.* 2) adv. *firstly; the earliest in time* 10, 32 (prob. for hóman).

homá'hti, homáχti, abbr. 'má'hti, 'máχti, pl. homáχhoti *who is ahead of, is first; who has the precedence;* ; cf. le=omáχti.

homáχta-is, homá'htäs, pl. of subj. homaχhótis; 1) *I stand ahead, I am in front;* homáχ'hotit shihóki-titáyiha *which (tribe) could stand up and be foremost* 10, 38. 39. 2) *I am ruler;* homáχhotid ómis *they are the rulers* (of the Creek people) 18, 6; pómit homáχhoti-is *we are the leaders.* Der. hóma.

hóman, húman *before, in the front, in advance;* adv. of hóma. hóman wiláko-idshit *two going in advance* 16, 18. homá=fatcha 1) *towards the front;* 2) *the front part, façade.*

hómpäs, húmpäs *I eat;* the food consumed being of various kinds. humpáχatis *they ate* 14, 27; cf. lóχäs, pápäs.

hopíläs, pl. of obj. hopiláχäs and hopilhuídshäs *I bury, inhume, inter;* cf. i. 211. hopílatis *they buried* (the hatchet) 16, 39.

hopóyäs *I seek, look out for.* hopo-iyitángid *having sought, looked for* 16, 29; -ángis forms one of the past tenses, cf. i. 206, and hupáyi.

hopuitáki, pl. of hupúyua, q.v.

hotsä'dshäs 1) *I mark, make a mark.* 2) *I write;* cf. S, 6. and -hútchi in Chatahúchi, nom. pr., i. 129.

huanápsidshäs *I cause, give rise to offspring.* inhuanapsitóyäs *I am the offspring of him, her, them, &c.* Cf. hupúyua.

huilä'-idshäs, huiʻlä'dshäs, du. of obj. shihúyäs, pl. sabáχlidshäs 1) *I set up standing, I expose in an erect position.* inhuiläidsháχadis *they set it up in a standing position for* (i-) the blue bird 12, 16. 2) *I own,* said of animals; lit. "I set up (a beast) on its feet." Der. huíläs.

huíläs, huíʻläs, du. of subj. shihókis, isihókis, pl. sabáχlis; 1) *I stand, I am erect.* 2) *I stand up* as a leader, *hold forth;* huiʻla-itánkis, contr. huiʻla-ítanks *I have been standing;* huiʻlayánkis, contr. huíʻlayanks *I stood up repeatedly;* wákat sapáklis *cattle are standing* (there); shihóki (*or* sabákli) -titáyiha? *can they hold forth?* The -ha makes the sentence interrogative 10, 39. The dual is not strictly confined to two subjects, but may extend to a few, and also may represent a tribe, town: isihóχatis *or* síhokatis *they stood up, held forth* in the council 12, 1.

húya *net* of any description.

huyánäs, du. of subj. huyanhóyis, pl. huyanídshis *I pass, walk or ride by, go past.* pret. huyā'näs *I have gone, passed.* huyanípis, contr. húyanips *it is over, past, ended.* huyā'nis pret. *it is over, past.* inhuyánad *whenever it* (this period) *is past for them* 10, 35.

Huyáni, nom. pr. of the head war-chief of the Chíaha and Okmulgee Indians combined; called Whoyauni in text; lit. "Walking past"; "one who passes by," S, 12.

húʻli, hóʻli 1) *war, warfare;* h. míkko. h. kapitáni *war-chief, commander on expeditions* S, 9. 10. ínhuʻli míkko *their war-chief* S, 12. 13. húʻlin háyäs *I wage war.* húʻlit áyäs *I go to war, I start on the warpath;* cf. 12, 26. 14, 19. húʻli-á·la, cf. i. 166. 2) *enemy, hostile opponent.* pónhoʻli, púnhoʻli *our enemy, enemies* 12, 3. ihúʻli *his enemy* 12, 28.

hû'mpita, 1) infinitive of hómpäs, q.v. 2) *food, eatables, provisions*. húmpita hátki *maize boiled into grits* i. 186.

húni'la *north;* húni'la fátchan *from the north* 10, 17.

hupáyi, hopá-i, adj. 1) *what is far away, distant*. Yufála hupá-i, nom. pr. loc. *Far-away Yufála*. 2) hopáyi, h. míko or h. imíssi, a *warrior* combining the qualities of a *leader* and *conjurer;* cf. i. 165.

hupí'li, 1) *fog, haze*. 2) Hupí'li, nom. pr. of a chief of the Sáwokli tribe, Opithli in the English text 8, 14.

hupúyua, pl. hopuitáki, hubuitági *offspring, child*. The singular is obsolete, but occurs in war-titles; cf. ístudshi. hopuitákin inlóχadis *ate up their children;* lit. "ate up the children from them" 8, 21.

i-, iy-, yi- a prefix, when not representing the 3d pers. sg. or pl., sometimes conveys the idea of a *return to, a repetition:* i-apóχadis *they settled again* 8, 23 (see läíkäs); iyi-munáhin *relating it to them* after their *return* 18, 14. (better: iy-im-unáhi-in); cf. also yihídshäs.

i-ádshid, yádshid; see tchayádshīs.

i-ahu'lkasídshäs *I keep with me, about me* 14, 21. (object collective or in the singular number).

i-alúnga, yelû'nga, yélunga *root, tuber, bulb*. náki yelúngan *some kinds of bulbs* 14, 26. Also used in the abstract sense: root of evil, etc.

i-ätíkäs, iyatíkäs, more frequently yätígäs, yatíkäs *I interpret, translate for* somebody. i-ätikóyatis *it was interpreted for* 8, 5. inyatikóyatis *somebody's speech was interpreted for another*.

idshákadis 12, 33. for hidshákadis; see hídshäs.

ídshäs, same as hídshäs, q.v.; abbr. chiefly in compounds.

idshókua, (i-)dshóχua; see itchókua.

ídshû, ítchu *deer*. ídshu pá-iχka *elk;* lit. "hallooing deer." ítchu='láko, abbr. tchu'láko, tchuláko, 'láko *horse;* lit. "large deer."

ífa *dog;* Yutchitálgi imífa míkko *dog-chief of the Hitchiti*, probably a war-title 8, 11; ífudshi *young dog;* fa=húkti (for ífa húkti) *bitch*.

ifí'gi *heart;* lit. "his, her, their heart"; pofígi, pufígi *our hearts;* cf. fik'húnnäs; fíksiko i. 161. 163.

ifû'ni *bone, his bone;* ifúni *his bones* 14, 14; ifónin, id. 14, 21.

-iga, -ika; see -ga.

íhaliwa *food, provisions, eatables* 16, 3; originally "food carried on a journey, trip"; cf. hû'mpita.

ihókpi *breast, chest;* lit. "somebody's chest."

i'htchit; see hídshäs.

ihuláka *scalp;* technical term. Other terms are íka híssi, íka há'lpi, tíwa.

i-ilawídshäs *I fast;* lit. "I make myself hungry." i-ilawídshit (verbal) *fasting* 10, 32; cf. ilaúko.

i-imanäidshäs *I defend myself;* lit. "I help myself."

iyimunáyäs, pl. of subj. i-imunáyis; 1) *I say to myself;* 2) *I relate after returning* 18, 14; see unáyäs and i-, prefix.

íka, íga *head;* lit. "his, her, its head." tcháka *my head;* púka *our heads;* cf. i. 203. íka há'lpi *scalp.*

íkana 1) *earth, ground, earthy matter, soil;* the "*Earth*" personified, in íkana idshókua, or íkan=dshó*χ*ua *the Earth's mouth* 8, 18. 19. ikan=haúki *pitfall* 14, 12. 13. 2) *land, country, domain, territory.* Sometimes abbr. into kan- in compounds.

íkosīs, íkk'osis *it is smoking;* ík'osiga *because it is smoking;* cf. íkuadshi.

íkuadshi, íkk'uĕdshi, íkodshi *smoke.* íkodshid óměka *on account of smoke* 12, 39.

ilaúko *hunger.* Der. íläs.

íläs, pl. of subj. pasátkīs *I die, expire.* íli, pl. pasátki *dead.* itchkimíli (for itchki=imíli) *orphan,* both parents deceased. istí ilāti *dead person, corpse.* tsalíbis *I am dead.* ila'lánus *he is on the point of dying.* hámkúsit ílātin ahi'lit ómīs *it is better that one only should die* 14, 11.

ilîdshat, ílidshan, apher. lítchan, lídshan; postp. *underneath, below* 16, 39; the opposite of únapa, q.v.

ilídshäs pl. of obj. pasátäs *I kill, slay;* ilítchatis *he, she, it killed;* ilíhotchatis *they killed* 10, 23; tchilídshäs *I kill thee;* i-ilídshäs *I kill myself;* ilí'tchkan (for ilítchi*χ*kan) for the purpose *of killing* (our enemy) 12, 3; ma ilí'htchûf, or ilí'htchi ófan *when they had killed this one* 14, 18; í'lgi imilídshagi-táyad *how they could* or *might kill its father* (im- refers to relationship) 12, 20. man ilidsházatis *they killed* him *there* 12, 24; ilidsházatis 14, 14; pasátit *killing* 8, 31; pumpasátit omítutanks *it is wont, in the habit of killing from us* people belonging to our (pum-) tribe 14, 4; pasat'hóyis *they are killed;* ístin pasátît *killing men, persons* 12, 15; ísti pasátit (same) 14, 17. Der. íläs.

flidshi, nom. pr. of a Creek chief; Eliche in the German original.

i'la-, prefix: 1) *away from home, house, lodge;* 2) *from it, away from there;* 3) *further on, onward, after another, against;* cf. i'li *next*, and i'lanáfkäs. Embodies the prefixes í'li- and a-.

i'la-átäs, du. of subj. i'lahóyis, pl. i'la-áwis *I return from; I return home;* preter. i'lā'täs *I have returned from;* i'la-áwid ómatis *they habitually return from* 10, 35.

i'la-awaihígäs *I am next in order after* another, *further on;* i'la-aweíhîgadīs *after these they came next* 12, 10. Der. awaihígäs.

i'lafúlgäs, du. of subj. i'lafulhókīs, pl. i'lafulídshīs *I return, turn back from;* i'láfuli'htchit *having turned back from* 8, 22; i'lafulízshit *turning back* 12, 34; 'lít i'lafulídshin ô'mad hát'hagid *if the arrows had* (been) *returned white* 16, 2.

i'la-itídshäs, i'lahitídshäs *I make a fire away from the house, town* 10, 34.

i'lalákäs, du. i'lalahókis, pl. i'lyédshīs *I return, come back;* i'lalágit ómatis *returned habitually, regularly* 14, 17; i'li-étchatis, or i'lyétchatis, the people *returned to* that place 14, 19. Der. alákäs.

i'lanáfkäs *I strike, hit by approaching* the object *to* some other object; i'lanafaíkäs, one of the past tenses; i'lanafaí-kit *striking after having approached it* to the pole 10, 22. Der. i'li-, a-, náfkäs.

i'la-óssäs, du. of subj. i'lá-ulgīs, pl. i'lásosīs, *I come out, emerge, issue out of.* ísti i'lásosa-igōs kómadis *they believed that the people would not come up from* (the river) 16, 9. Der. a-óssäs; cf. asóssäs and i'lóssäs.

i'lásitch'häs (same form for pl. of obj.) *I shoot back at with* something; i'lásidsh'hatis *they shot* the arrows *back* where they came from 16, 1. Der. i'la-, isi-, ítch'häs.

i'látäs, du. of subj. i'lat'húyīs, pl. i'láwīs, *I return, revert, come back*; fut. i'lata'lánäs *I shall return.* i'lasawa'la-nátchkatis *ye could have returned from there* (-'lánäs, suffix of future tense, *I am going to;* cf. i. 206; -átchkatis, 2d pers. plur.) 16, 4. Der. átäs.

i'l'hídshäs *I travel, go to see; I go to look at.* i'l'hí'htchit (pret.) *having started to see* 18, 13. Der. hídshäs.

i'li 1) *next, following, subsequent* in time or space; a term often implying gradation. i'li hóma *in front of, further on.* i'lín hayátgi *on the next day* or *dawn* 8, 28. 14, 34. 36. i'lín yúpa *subsequent* in time, space; 2) as a prefix: í'li-, i'l-, *away from;* the second -i- is sometimes the pron. poss. 3d pers.

i'liétchatis; see i'lalákäs.

i'liyukfanídshäs, pl. of obj. i'liyukfanfanídshäs *I place at the end or top of,* when the object is at a distance; cf. fû'sua ítun i'lĭyukfángis *the bird alights on the tree-top.* Der. í'li, yúksa, fanídshäs.

i'límpohäs *I listen to, I hear* somebody or something after going a distance. i'límpoχit *listening to him* (the king) 18, 14. Der. póhäs.

i'limú'läs *I reach to, come up to;* i'limu'läítchatīs *they reached* him *out there* 14, 2. Der. í'li, im-, ó'läs.

i'limu'hweíkäs, i'limuχwaíkäs, pl. of obj. i'limu'hpalátäs *I throw* an object *towards* and *for* somebody 14, 9.

i'lisalákäs, du. i'lisalahókis, pl. i'lis=yĕ'dshīs 1) *I bring, carry back, return to;* i'lisaláχatis *brought it back* 12, 17. 2) *I return on horseback, mule,* etc. Der. i'li-, isi-, alákäs.

i'litchíyäs, du. i'litchihúyīs, pl. i'litchíyīs *I go far into, I enter over yonder.* Der. tchíyäs.

í'lki, í'lgî *father,* lit. "somebody's father"; tchá'lgi *my father;* í'lkisígō, í'lki=sosigō *fatherless;* cf. =súsiko.

i'lkitúyäs, i'lkitóäs or ánit i'lkitúyäs *I am the father of;* i'lkitó-aitis, for i'lkit•ówetis, i'lkit=úwaitis *is probably, might be the father* 12, 19.

'ló'läs, pl. of subj. i'ló'läidshīs *I go and reach a spot distant* from where I am or have been speaking. Also abbr. into 'ló'läs; ó'läs means *I reach there.* Der. í'li, ó'läs; cf. i'limú'läs.

i'lóssäs, du. of subj. i'lú'lgīs, pl. i'lisússīs *I issue from, come out, emerge in the distance,* or at some distance from. i'lû'ssaχōs *I do not come out, do not issue from.* i'lússigōd ómin *not coming out* (-gō, -χō negat. particle) 16, 8. (For i'lasósa-igōs, pl. *they would not come out again* 16, 9; see i'la-óssäs.) Der. í'li, óssäs.

imáhilissua; see hílissua.

imahitídshäs *I set fire to* wood or other combustible. Der. ahitídshäs.

imá'la a war- and busk-title; corresponds nearest to our *disciplinarian,* or *whip;* lit. "one who moves among them"; the one going in their midst, or making them stir, move. Der. im-, á'läs.

imantalídshä-is, pl. of subj. imantalídshi-is *I surpass* somebody or something; adshúlga, yíktchîda imántalidshä-is *I surpass in age, strength;* lámhi imántalidshid *excelling over the eagle* 12, 14. Der. mántaläs.

impaskófa the inside area of the "great house," i. 173.

imapóskäs *I fast on purpose, I fast with a certain intention;* imapóskit *fasting* or *having fasted* 14, 20. Der. im-, a-, pō'skäs.

ímäs *I give to;* ímatis *they gave to* 16, 39.

imi- and im- compose many verbs of a *reflective* signification; cf. those in an-.

imititákuidshäs (and i-ititákuidshäs) *I prepare myself.* Der. amititágîs.

immalákatis; see alákäs.

impíngaläs, pl. impingalágīs, *I am afraid of, frightened at;* impingalagí *afraid they,* verbal of the present tense, 10, 7; cf. isapingalídshäs, tchapíngalīs.

imû'nga', î'mmungă 1) *his, its nature, characteristics, peculiarity;* for 18, 9 see wäíkäs. 2) *his, its custom, habitude.* Also used adverbially: imúngat *continually;* with ō'mis 10, 7. 14, 15.

imúngis *it is its habit, it continues to* 10, 7 (for imúngat ō'mis 14, 15; see isáläs and imû'nga). emúnkatis *were accustomed to* 16, 32. imúnkatis *they continued* 16, 38. apóki imúngatātis *they continued to live* 18, 2.

iná, pl. inági, *body*, lit. "his, her body"; tchaná *my body*; tchinátaki *your bodies* 16, 36.

ínadshi *breast; side, trunk of body*; lit. "somebody's breast."

ináhäs *I recite a war-formula*. Formulas of this kind were intended to save oneself from critical situations during battle.

ínhītchkin; cf. ahítchkäs.

inkapákäs, pl. of obj. inkapakákäs *I leave, depart from*; only used with in- prefixed. Kúsa talófa ingapáχkît *leaving the Kusa tribe* 14, 23. ma apókati inkapáχkit *leaving that stopping-place* 12, 31; cf. 14, 30.

ínki, íngi *hand*, lit. "his hand."

inúkua, ínokwa *neck*, lit. "somebody's neck."

i-ómat, yómad *now, at present* 14, 24; cf. hayómi.

ipákîn, abbr. ípa *six*; ipákäs *or six* 10, 35; ísti 'sipákan *the sixth person*; ipapáχäs *each six*; ipahákäs *six to each one*; nitá ípagin *six days* 14, 20.

isagi'létchka 14, 19; cf. aki'läítchka.

isahopáka *mark, sign, symbol for* a thing or idea; hí'lkida i. *symbol for peaceableness* 16, 34; cf. 12, 28. Der. ahopáka.

isáyäs, du. of subj. isahóyis, pl. isapíyis *I go, travel with an object in view; I travel with* something; isapí-in ómad *when they travel, while carrying it along* 14, 21; ássitchi isápiyad *while marching in their pursuit* 16, 26. 28.

isayípäs, du. of subj. isahoyípis, pl. isapi-ípis 1) *I ride on horseback, mule, &c.* The suffix -ip- inserted into isáyäs, q.v., gives an elegant turn to the sentence. 2) *I carry off for myself, for my use* 12, 17.

isákäs, hisakäs, 1) *I breathe;* 2) *I live, am alive*. The dual isahókis is also used for a plurality of subjects.

isákita 1) *breath;* 2) *life;* Isákit' immíssi (or imísi) *the Holder of Breath, the Giver of Life;* the chief genius in Creek mythology, corresponding to the Great Spirit of the more northern Indians; cf. vol. i. 216, where the name is explained.

isá'läs, abbr. sá'läs, sásäs; du. of subj. iswilágīs, pl. isfúllīs, isfóllīs. 1) *I have, hold, carry with me, I have about me while going, moving;* isfúllatis *they had it with them* 10, 24; ahitídshit ísfullatid *having it along with them lighted* 10, 18; ahitídshatit isfúllin *having kindled the fire they had it with them* 10, 10; sá'li, sá'lit ómati *when they have it about them*; isfólli imúngat ō'mis *they are in the habit of carrying* them *along on their way* 14, 15. 2) *I carry about, along with me* with the idea of ownership. 3) abbr. in the *impersonal* voice to sá'līs, sá'latis, or sásis, sásatis: *to be about, to exist there;* said of *some, a few* anim. or inan. subjects only. apóki sásin, sásatis *some lived there in settlements* 18, 3. 4. u'hapíyî sásatis *some, a few went there* 16, 6. Der. á'läs.

isáktchiyäs, du. isaktchihúyīs, pl. isaktchíyīs *I go down into* (river, &c.); hídshit má ísti úyuan isáktchiyit *they found out that this people had gone into the water, river* 16, 9. Der. aktchíyäs.

isámumi, sammómi *better than, preferable to.* isámumid-ēs *even better* 12, 36. isamúmit ōs *it is better than.*

isanhí'lis *it suits me, it is good for me;* istchinhí'lis *it is good for thee;* ispunhí'lis *it suits us, is good for us;* isinhí'h'lis *it suited him, them.* Der. isi, an-, hí'li.

isapingalídshäs, pl. of obj. isapingalakuídshäs *I scare off from* something, *capture* or *take away from;* isapingalídshin ómof *at the time of capturing* the town *from them* 16, 23. Cf. impíngaläs.

isawäitchítchikōs *I persist, persuade;* lit. "I do not let alone, I do not quit" 16, 38. Der. waíkäs, -kō.

ísäs, pl. of obj. tcháwä-is, tcháwäs *I take, seize, grab, get hold of; I hold; I carry with me.* í'hsäs *I took,* pl. of obj. tchá-'hwäs (-'h makes it preterit) í'hsit *having taken* in the sense of *keeping it* 10, 23. isi-titayipíalis *we will be able to supply ourselves; we will be each, one by one, furnished* (der. ísi, verbal of ísäs; titáyis *to be able;* -ip- here expresses the reflective and distrib. pronoun) 16, 23. talófan imísatis *they captured the town for themselves* 16, 25. imî'hsit *having taken it from* them 16, 38. A paradigm of this verb will be found in i. 205–209.

isfúllīs, cf. isá'läs.

is'hídshäs *I find, discover;* is'hí'htchit *having found* ('h mark of preterit) 16, 27.

isi-, is- 1) instrumental prefix, as in isnáfkäs, isnihäídshäs. 2) isi-, shi-, si-, etc., prefix of the comparative in adjectives: isihí'li *better;* cf. i. 200. Der. ísäs.

isiafástäs *I rub myself with;* when used of medicine, *I administer to myself.* isiafástid ómants *they habitually administer* the medicines *to themselves* 10, 31. Cf. ómäs.

isihí'li *better*, comparative form of hí'li *good;* isihí'lit ómati *to be the better one, that it was better* 18, 11. Der. isi- prefix, hí'li.

isihókis, i-shihóχis, issihúkis; du. of huíläs, q.v., the usual form being shihókis.

ísi-imanäídshäs *I defend myself with;* istómit íssi-imanäítchi-ko-tidáyin háyatis *it* (the rat) *made it* (the bird) *defenceless;* lit. "not (=ko)in any manner (istómit) to defend itself (i-imanäítchi, verbal) with (iss-, for is-)-tidáyin (able) háyatis (it rendered) 12, 23; cf. i-imanäídshäs.

isimanóle *far removed*, or *taken away from.*

isimatchulä'-is, isimadsulä'yis *I am older than, surpass in age:* ístin i. *I am older than he, she, somebody.* Der. atsúli.

isinyiktchä'-is, isinyiktchä'yis, pl. of obj. isinyiktchágagis *I surpass in strength, power:* ístin i. *I surpass* somebody *in force.* Der. yíktchi *strong.*

isinkánhäs, pl. of obj. isinkanhákäs *I trap, allure, endeavor to capture.*

isítch'häs, pl. of obj. isitch'hákäs *I shoot at with* something: 'lí hátkin isítch'hatis *they shot white arrows with* their bows 14, 38. 16, 20. Der. ítch'häs.

ískäs *I drink.*

iskí'läs *I recognize by, by means of*, as of a mark. Der. kí'läs.

iskuídshäs, pl. of personal obj. iskakuidshäs *I cause, make* somebody *drink* 16, 33. Der. ískäs.

iskulapákat *seventh* 14, 17: where the full form is iskulapáki; níta iskulapákatin *on the seventh day* 14, 20.

isláfka what serves for cutting: *knife* 14, 29, etc. Der. láfäs.

isnáfkäs, pl. of obj. isnafkákäs, isnafnákäs *I hit with, strike with;* isnáfkit *striking* him *with* 14, 14.

isnihäídshäs *I adorn myself with, I use as personal ornament:* lit. "I cause myself to be fat with." ihú'lit isnihäídshit *his enemy having provided himself with* a white feather 12, 29. Der. níha.

ispógi *at last, lastly* 10, 16. Der. póki.

issi. cf. ássi.

ī'ssu, ī'su *ashes;* ī. háyi *embers, hot ashes;* ī. móka *dust rising in the air;* lit. "smoking ashes."

ísta 1) *which? what?* interrog. and demonstrative-relative pronoun: ista itáluat? *which town, nation?* 10, 38. ísta italuatátit u'h'lánin ómat *which tribe would be the first* (-tátit) *to cover* 12, 4. 5. 2) *whichever, whatsoever;* istama *where, somewhere.*

istama-ítäs, istamaítäs. adv. *in either direction, by any way, all around* 16, 13. Der. ísta, ma, ítäs (either way).

ístan *wherever;* ístan apíyit *wherever* they were *marching* 16, 18.

istä'mat, pl. istämatáki 1) *who?* interrog. pron., as in a query: páksangīn istin náfkäyanks! "istä'man?" *I struck somebody yesterday!* "*whom?*" 2) *anybody, anyone, anything.* 3) When connected with a negative or privative particle or verb, both together form a negative pronoun, like the French ne .. pas, ne   point, aucun   ne: istä'mat sîgátis *none could, no one was able to* 10, 21.

ísti, pl. ístalgi and ísti: 1) subst. *person* of either sex, but chiefly used of males: ísti hátki *white man;* ísti tcháti *Indian;* ísti Maskóki *a Creek Indian;* ísti Maskóki ímmiko *a chief of the Creeks.* In the plural ísti means *people, tribe, nation;* ísti Maskokálgi or Maskō'ki *the Creek people* 8, 1. 2. 7. ísti Natuági *the Iroquois Indians* or *Six Nations* i. 61. 2) pron. *somebody, some one:* ísti hápu *somebody's camp.* Cf. istiga-há'lpi and stillipaíχa; isinyiktchä'-is.

istiga-há'lpi *scalp,* lit. "somebody's head-skin." Der. isti, íka, há'lpi.

ísti-pápa *lion,* lit. "man-eater."

isti-tó'lkua, -tú'lkua *somebody's knee* 12, 11: cf. tó'lkua.

istófan 1) *when?* when used interrogatively. 2) *at any time, some time;* when connected with a negative or privative particle or verb, it means like the French ne .. jamais: *never, at no time;* istófan ilí'htchikos *they never kill him* 12, 30.

istófäs *always* 16, 18. 18, 1.

istómäs *as if in some way, although.* múmitu istómäs *nevertheless* 8, 24. mómi istómäs *nevertheless* 16, 5.

istómi, istó'hmi 1) pron. indef., which forms a negative pronoun whenever connected with -gō, -kū or other negative or privative particle, as occurs also in Romance languages: *any, of any kind, any sort of;* ísti istómid *any person, people.* 2) *what kind, what sort of;* níni, ísti istómit *what kind of a path, trail,* or *people* 12, 35. 16, 5. Der. ísta, ómi.

istomídshäs, pl. of obj. istomidshákäs 1) *I perform, act;* istumidshäyátit? *how could I do it?* 2) *I do something with, make use of;* tútkan istomitchakigatís *they did nothing with* that *fire* 10, 14. istomidshikatis is used (10, 15. 16) in the same negative sense, for istómi can be used interrogatively and *negatively.* istumítskatad (-tati) *how to make use of them* 10, 26. 3) *I devise a plan, make a plot;* istumidshakátit *that it should propose a plan* 12. 20. Der. istómi.

istómit, istó'hmit, adv.: *in such a way, in which manner, how;* also used interrogatively: *in which way? how?* 12, 23. Connected with a negative particle or phrase, both together form a negative expression: ísto'hmit ómatin sigátis *none could* state *any way of doing so* (quieting the pole) 10, 21. Der. ísta, ómi.

ístudshi *child* 10, 22. Der. ísti, -udshi; cf. hupúyua.

istukä'-idshi, ist=okä'idshi *noisy* 10, 21; *making a strange noise.* Der. ísta, ókäs *I utter* (sound).

istúngun *in spite of, nevertheless, notwithstanding.* talepó·lat omídatit-äs i. *although he was a stranger* 18, 12. i. yakápi hāks *he walks perfectly well again* (said of one who previously broke his leg); i. punayí hāks *he can speak well again* (after losing speech); i. hasóti hāks *the sun shines now* (after a long rain).

istchagi'lkis *I am known, recognized by* something; future istchagí'lga'līs, in: istchigi'lgá'li tchinátakin *for your bodies to be recognized* (have them whitened) 16, 36., this verbal being governed by hat'hē'dsaksh! Passive of iskí·läs.

istchatídshäs *I redden, paint red with* something: istcha-ditchagí'hlĭs *let us redden it with* red clay 12, 2. Der. tchatídshäs.

isuχ'lánäs, pl. of subj. isuχlomläídshĭs *I cover up with;* isúχ-'lanatis *they covered up with* 14, 6. Der. ísi-, uχ'lánäs; cf. wákäs, takwakídshäs.

iswilágĭs, du. of isá'läs, q.v.

-it, -in suffixed, indicates the reason or cause of an action or fact; mahátin 14, 11. hátgātît etc. *white being the emblem of peace* 12, 28. háhokadin *on account of the perpetual whooping* 14, 32. tcháti-algátin *for being bloody* 16, 35; cf. -ga.

it-, iti-, prefix forming the reciprocal voice of transitive verbs; cf. i. 209. It is derived from íta *other, another,* and, when appearing in the form iti-, the second i- is the pronoun of the 3d pers. sg. or pl.

íta, pron. indef.: *other, another;* ísti ita, or ísti ítäman *some-body else.* Composes ítan, itäman, ítäs (in istama-ítäs) and the prefix it-, iti-.

itálua, itáloa, see tálua.

itapómis for itáwa ómis *it is like, it is the same;* lit. "it-self so it is, the same it so is" p. 59 (-wa having changed into -p-). Cf. matapómis.

ítau, íta-u'h, itawú *else, other;* náki íta-u súlkì *many other objects* 10, 12. Lit. "another too."

ítäman 1) *separately, apart;* lit. "there in other parts" 10, 34; 2) *differently, variously.* Cf. ítau.

itídshäs, hitídshäs *I make, build a fire;* cf. 10, 34. tótkan imitídshäs *I kindle a fire for somebody.* takitídshäs *I make fire on the ground, floor.* Der. ítu *firewood.*

itihídshĭs, pl. itihidshákĭs *we meet each other;* lit. "we see each other." itihídshatis *they found, met each other* 10, 9. Der. iti-, hídshäs.

itikä'-idshäs *I agree,* lit. "I say so to another" 12, 6. Der. kä'-idshäs.

itiládshäs, du. & pl. itiladshákis *I am joined to, connected with;* itiládshi=hí'lit ō's *it is truly, really joined to* p. 59. Der. aládshäs, v. intr., *I rejoin.*

itimayopō'skīs *we dispute among ourselves*, lit. "we answer one another" 10, 39.

itimatíχka 1) *inhabitant of the same place*, lodge, house; "*co-dweller*"; 2) *family;* cf. atíkīs, pl. of apaígäs.

itimpunáyäs, pl. itimpunayákäs 1). *I talk, converse with;* itimpunayágit *speaking to* 12, 20. 2) *I deliberate with others;* itimpunäyákatis *they took counsel with* 12, 21. Der. punáyäs.

itinhu'lä'dshäs *I cause warfare; I prompt* others *to go warring*. Der. hú'li.

itipákäs, pl. of subj. ituχkálgīs *I come, go together* with others, *intermingle with* them: itokχálgit apóki *to live intermingled together* 18, 2; cf. ituχkáläs.

iti'laputäs, du. of subj. iti'laput'húyīs, pl. iti'laputídshīs *I go through, pass across* (underbrush, &c.) 14, 10.

ititákuidshäs *I am preparing, I make ready;* i-ititákuidshäs *I prepare myself* 14, 19; cf. amititágîs.

ítkis, pl. of subj. it'hókis (preferable to it'kákis): v. intr., *it burns;* cf. tótka.

ítu. íto 1) *wood, timber;* ito-ú'h matáwat *also of the same wood* 10, 25; *firewood.* 2) *pole; beam, stick* 10, 22.

itu'hlátkäs, pl. of obj. itu'hlátkākäs *I attack, begin a fight* or *scuffle with.* Der. iti-, u'h-, látgäs.

itu'hwalápkäs, pl. of obj. itu'hwalapkágäs *I cross, go across* (road, pathway, &c.) ma níni ituhualapíχtchit *having crossed this pathway* 12, 34.

ituχkáläs, pl. of obj. ituχkalákäs *I mix, mingle with;* lit. "I break up with." ituχkálan *mixing, commingling it* 10, 18. For itoχkálgit 18, 2 cf. itipákäs. Der. iti-, u'h-, káläs.

ítcha, ítsa, ítch'ha *gun;* formerly *bow.*

itcha=kuadáksi, itsa=kutáksi, itsa=χudáksi *bow*, lit. "crooked gun" 12, 21. 22. 14, 27.

itch'hásua *beaver* 14, 28.

ítch'häs, pl. of obj. itch'hákäs *I shoot at.* Der. ítcha.

ítchki, í'tskî *mother*, lit. "his, her, their mother." ítchki=síku, í'tski=súsikō *motherless* 10, 22.

itchókua, idshúkua *mouth*, lit. "his, her, its, their mouth" 12, 29. íkan=dshóχua *the mouth of the Earth* 8, 18. 19.

i-unáyäs, iyunáyäs, pl. of subj. iyunáyis *I go and refer, tell.* Der. unáyäs.

i-upan, see yúpan.

Iwanági, nom. pr. of a chief of the Lower Creeks: "Belted" 8, 15. In text: Ewenauki. Der. iwanákäs.

iwanákäs, iwanáχäs *I put a belt on, gird myself with a scarf; I tie around myself.* Der. wanáyäs.

ya, í-a *this;* cf. hía.

yáfgi, yáfki *eve, evening;* yáfgadi, yáfgadîn, or hia yáfgadin *this evening; in the evening,* lit. "after it became evening" 8, 29.

yahá-ikäs *I sing.* yahaígit *by singing* 10, 26. yahá-iki ómäs *as if it was singing* 10, 19.

yahaíkida 1) *act of singing* 10, 3. 5; 2) *song.*

yánasa, yĕnása *buffalo;* cf. i. 212. yánas'-há'lpi *buffalo-skin* 8, 6.

yatígäs, yätíkäs; cf. i-ätíkäs.

yatchákäs *I chew, masticate.*

yawaíkäs, pl. of obj. yapalátäs 1) *I throw down to, before; I bring and throw down.* yawäígit *throwing down before them.* yaweíkit (for i-aweíkit) same 12, 4. yawaígadīs *they laid down before* the others 12, 12. 2) *I throw myself away* (i-, y- reflect. pron.) Der. awaíkäs.

yé-idshīs, yédshis; cf. alákäs.

yelúnga, yalúnga, see i-alúnga.

yihídshäs, pl. of obj. yihidshákäs *I return to see.* yihidsháχadīs *they returned and saw* 12, 35. Refers to their return to the place where they came from. Der. hídshäs.

yíktchi, pl. yíktchagi *strong, powerful.*

yíktchida, yíktchîta *strength, physical force.*

yómad, same as i-ómat, q.v.

yómen, i-ōmen, í-oman, postp. *together with* 14, 27.

Yufánti, coll. Yufantálgi, nom. pr. of a tribe called Eufantees in text; misspelt for *Yufáli* 8, 15.

yúksa, iyúksa, í-uksa *at the end of it* 8, 32. Der. i-, úksa.

yúpan, yúpa, í-upan, íyupan *behind, in the rear of;* properly, *behind him, her, it, them* 8, 23; *after that* 12, 31. í'lin yúpa *subsequent in time or space.* yĕbó=fatchan áyatis *he went toward the back part.* Cf. únapa.

Yútchi, coll. Yutchîálgi, nom. pr. of the *Yuchi* or *Uchee tribe* of Indians, differing from the Creeks in race and language. But the Yutchitálgi or Euchitaws of the text are the *Hitchiti tribe*, not the Yuchi 8, 11.

káyäs 1) *I give birth to twins* or more *offspring at one time.* 2) *I come forth* (springs of water); cf. hitchkuidshäs, säidshäs, wi=kä'wa.

kákida *settlement, habitation;* either of two (man and wife) or of a tribe, nation; inkákîda háyatis *they made their habitation* 8, 20; cf. apókita, läíkida.

kákis, du. of läíkäs, q.v.

kaláχäs *I gnaw;* kalágit *gnawing* it (verbal of present tense) 12, 23; cf. káläs.

káläs, pl. of obj. kálgäsäs *I break, break up*, as bread; cf. ituχkáläs, kaláχäs.

kán=tchábi *low, low-lying.* Der. íkana, tchápa.

kapitánî (span.) *captain, war-chief;* inhú·li kəpitáni *their war-leader* 8, 15.

kasápi *cold*, said of water, weather, limbs, &c.

Kasíχta, Kasí'hta, coll. Kasíχtalgi, Kasí'htalgi, nom. pr. *Kasí'hta* or "*Cussetaw*" *Indian.* The tribe belonged to the Lower Creeks and originally were one people with the Kawítalgi, as stated 18, 3 sqq. Mentioned in the legend 8, 9. 19. 12, 7. 14, 5 etc.

Kawíta, coll. Kawítalgi, ísti Kawítalgi; nom. pr. *Kawíta Indian.* This people formed a tribe of the Lower Creeks after separating from the Kasí'hta, as narrated 18, 3 sqq.; cf. 8, 8. 18, 4.

kä'-idshäs, kaídshäs, kē'dshäs, pl. of obj. käidshákäs (objective conjugation i. 210) 1) *I utter sound, emit voice;* cf. hákäs. 2) *I say, tell, speak; I say so, order:* kä'χtchid *ordering them* to see 10, 4. Cf. itikä'-idshäs. 3) *I call, call by name, name:* kédshad *called, named;* same as mágidan 12, 38. kaítchid *calling it* 10, 6. kē'dshid *called, named* 14, 35: käidsháχatis *they called it* 12, 25: kä'hodshid (pl. of subj.) hákit ōs *thus called*, lit. "called sounded so" 14, 25; kähódshid ómis *are called* (Kawitas) 18, 5.

kä'χtchid, see kä'-idshäs.

kí'la, coll. kí'lalgi *one who diagnosticates diseases.* A special kind of medicine men among the Creeks, different from the alíktchalgi, who treat and nurse the patient. The kí'lalgi also find objects lost. Lit. "one who knows." Der. kí'läs. Cf. iskí'läs, hilis'=háya.

kí'läs, gí'läs, pl. of subj. kí'lis *I know, am acquainted with;* gí'lidan kómidut *wanting to know, to find out* 14, 39; gí'lagit ōs *they are cognizant of the fact, know about it* 18, 11. 12; cf. akí'létchäs, iskí'las, istchgí'lkis.

kítäs *I am sawing;* ítun k. *I am sawing wood, timber;* cf. fóyäs.

kóha, kóa, kúha *cane, cane-stalk, reed* 14, 28.

koχ-, kó'h-, kú'h- prefix: *upon the head, on the top of;* a compound of íka and uk-(uχ-).

koχtchak'hídshäs, pl. of obj. ko'htchaktchahídshäs *I stick upon the head, on the top.* lámh' ihádshi ko'htsaktsahídshid isfúllid ómis *they are in the habit of carrying the eagle's tail*(-feathers) *stuck upon their heads* 12, 27. Der. koχ-(prefix), tchak'hídshäs.

kolapákin, kulapáχin, abbr. kólapa, kólap *seven* 8, 4; nitá kulapáχäs *on seven days* 10, 35; kolapakákäs and kolapahákäs *each seven:* cf. i. 202.

Kolós=hatchi, nom. pr. of a stream 12, 37; cf. Note.

kómäs, kóma-is 1) *I reflect, think, suppose, believe;* kó'hmet (for kó'hmit) *having thought, guessed at* 10, 1; kómagid ómis *they are thinking;* verbal pres. 3d p. pl. 12, 25. kómākika *because, as they thought* 8, 24 (-ka causal suffix); kúmhuid ómīs *it was believed* 16, 12; komhuyidā'dis *it was thought, regarded, considered* (pret. pass.) 12, 9. 2) *I want, wish, desire:* hítchitan kómit *desiring to see, to find out* 16, 6; áyitan, kí'litan kómäs *I desire to go, to know;* momítchita kómit *wanting, trying to do so* 12, 7; komá-i=hi'l'sh *I am very anxious:* kómitan *wishing* (to have the question decided who should rule) 10, 39.

konáwa, χunáwa *bead,* cf. tchátu.

Kósa, Kúsa 1) nom. pr. of an ancient town of the Upper Creeks on Coosa river, Ala. 14, 1. 23. The Cheroki call all the Creek tribes Kusa-people. 2) Kósa, ísti Kósa, coll. Kósalgi: *Kusa Indian* 14, 3.

-ku, -ko, -go, -χo, etc. *not, mis-*, privative particle incorporated in adjectives, verbs, and particles: hi'liko *bad, wretched*, "not good"; ítski=susíku *motherless*: múmikun, cf. mómäs, etc.

kuatáksi, kutáksi, χudáksi *crooked, curved, bent over*; itcha=kuadáksi *bow*, q.v.

kú'läs, kó'läs *I dig, excavate*; íkanan ku'la-ít *having dug* a hole *in the ground* 14, 6.

kúsua *nut*; tsul=íkûsua *pine-nut*, lit. "of the pine its nut" 14, 14.

láfäs *I cut, gash, carve*, as with an axe, knife, scissors, etc.

lámhi *eagle* 12, 27. 30. lámhi-u *the eagle also* 12, 25.

láni 1) *green*; also páhi=láni *green*, lit. "grass-green." 2) *yellow*; lánitut ómäsim *although it is yellow* 12, 2.

lapátkin 1) *on land, out of the water*: 2) *in the woods*; cf. án'lawa.

lásti (*a* short), pl. láslati *black*. ísti lásti *negro*; lástis *he, it is black*. tútka lástid *a black* or *dusky fire* 10. 16.

látgäs, látkäs, pl. of subj. palátkīs (for the obsolete látkīs) 1) *I fall, tumble down*; látgis *he falls*, or *he is dead*; látlagäs *I jump up high* and *come down repeatedly*; also said of animals. 2) *I alight on the ground* (men, animals); látkid ómit *alighting there*, lit. "being falling" 14, 32; cf. aklátgäs.

látkida 1) *place of falling*. 2) *alighting place*; inlatkida *place where one person, animal fell, alighted*.

läíkäs, du. of subj. kákis, pl. apókis 1) *I sit down*; ása tchúkun läíkäs *I sit down in yonder house*; laíkas (lékas)! du. kákaks! pl. apókaks! *sit down! take a seat!* 2) *I am placed, located*; also said of inan. subj.: mán 'lánit läígid ómis *a mountain lies there* 16, 10; apopókin *in a bunch here and another there*. 3) *I settle down, am settled; I dwell, live, stay; I remain there*. wákat apókis, apúks *cattle is, stays* there; apóχadīs 8, 22 and apókatis *they lived* (there) 8, 31; i-apóχadis *they settled again*, i- having here repetitive function 8, 23; apóki imúngatātis *they continued to live* 18, 2; apóki sásin *some settled there* 18, 3; tapálan apóki sásatis *a part, some settled opposite* 18, 3. 4; ísti mán apógit *the people who stay, live there* 16, 12; apókit ōs *are living, settled* 16, 31; apógit *remaining* 8, 30; hían apókin *having encamped there* 14, 2; ístit apókin hídshatis *they found people settled there* 14, 37; tútka i'la-itídshit apókin *having built a fire apart, they stay there* 10, 34. Kósa mágida itálluat apókin *to a tribe called Coosaw which had settled there* 14, 1, 2; ma apókati *where they had lived*, verbal 3d pers. pl. 12, 31. Kósa apókati *having remained at Coosaw* 14, 23. Cf. apókita, kákida, läíkita.

läíkita, du. kákida, pl. apókita (q.v.) *settlement of, resting-place, habitation*, läíkita referring to one animate being only; cf. läíkäs.

le-omáχti, li-homáχti, pl. le-omáχtagi *scout; warrior* tracking the enemy or pursuing him. Der. íli *foot*, homáχti.

le-omaχtúdshi, pl. le-omaχtúdshagi *scout's companion*. Dim. of le-omáχti.

lídshan, see ílîdshat.

lipákfi, pl. lipákfagi *slimy* 8, 27.

loátchki, lowátski, pl. luatsloki (of distrib. signif.) *soft, compressible*; cf. kóha lowági i. 179.

lóktchīs *it is ripe*; tchalóktchīs, tsalúktsīs *I am ripe*; náki hóma lóktsat (verbal) *what becomes ripe first* 10, 32.

lóχäs, lókäs *I eat up, devour; I eat the whole of*. íkanat inlóχadis *the Earth devoured, ate up from them* (in-, the property of others) 8, 21; cf. hómpäs, pápäs.

lopä'-idshis, lopá-idshīs *it is proper, beneficial, appropriate*; tchalopä'-idshīs *it does good to me*; anlopaídshīs *it does good for* something *belonging to me*; tsilupä'-its *it is good for you*; also used ironically; punlopá-idshīs *it benefits us* (for púmin-); inlopä'-idshitad *that he has done good for them* 18, 12; cf. hi'lígäs.

lopútski *small*; cf. tchútki.

lúmhīs, lúmīs, lómhis; cf. o'hwákäs, u'h'lánäs.

'láko, pl. 'lák'lagi *great, large*; tchúkpi 'láko *one thousand* 8, 4; tchu-'láko *horse*; see ítchu.

'lá'lo *fish*; a totemic gens of this name is mentioned i. 155. 223; 'lá'lotäs pasátit *killing such as fish* 8, 30.

'láni (*a* short) *mountain, high hill* 10, 3, 10 etc. 'lánin óssît *coming out, issuing from a mountain* 10, 2.

'lí 1) *arrow;* ín'li apákīn *the arrows accompanying* or *belonging to* the bow 12, 21; ín'li alone, *its arrows*, would show a *belonging to;* in'litáti *the arrows* belonging to the bows as made in former times (-ta'ti) 14, 27: 'lí hátkin *white arrows*, the plurality being expressed by the verb háhi-it 14, 38; 2) *sting* of an insect, etc. Cf. 'Lé-kátchka, i. 137.

'ló·läs, abbr. from i'ló·läs, q.v.

·lúnutu, 'lónoto *flint-stone, flint arrow-head;* 'lonótutäs yó-mān *or together with flint* (-heads) 14, 28.

ma, subj. mat, obj. man, pron. dem. *this, that;* it points to an object within view, but further removed than when hía, í-a, yá is used. Ma 'láni *that mountain* 10, 3. 10. ma púkabi *that pole* 10, 23. ma apókati *that stopping-place* 12, 31. man wéyit ómīs *that they are wont to offer* 10, 32. má-o, má-u'h *this, that one also* 10, 15. 16. 19; mat yahaíkida ókid *that singing noise* 10, 5. Ma is placed before abstract nouns as well: ma agi·läítchka *that idea, thought.* Cf. ă'sa, hía.

mágäs, mákäs, máχäs 1) *I say so, state so; I agree with.* mákatis *he said, replied* 16, 2. mákakadis *they said so, agreed* (to do so) 12, 3. mágit *saying so.* "fik'húnnīs máχäs" sîgátis *there was none* (to say): "*I say it is quiet*" 10, 22. máχäyanks *I said so;* makaímatäs *I have said so long ago:* maχayántas *I have said so* very long ago. 2) *I call by name:* Kósa mágida *named Coosaw* 14, 1. mágidan *called by name* 12, 38. mágität (for mágitat) *called, named* 16, 10; cf. kä'-idshäs.

maháka, cf. aháka.

máhi, máki, máχi, pl. ma'hmáyi, maχmá-i 1) adj. *high, tall; great;* ítu máhi *a tall tree* (standing); hóktagi ma'hmáyi *tall women;* mā'hi *very tall;* Káwitalgi ímmiko máχit *the principal, head-chief of the Kawita people* 8, 8. 2) máhi is used as an adjective in locutions, in which we can render it as *adverb* only: *greatly, intensely, very*, and thus forms superlatives: máhi máhi *very tall;* istukä'-idshi máhit *very noisy* 10, 21; or it means, used as an adjective also: *really, indeed, just:* ma-ómofa máhin *just about that time, at the same time* 10, 38. omálgi mahátin ahí-·lit ómīs *it were better that the whole people* should die, lit. "all really, all in fact, the entire people" 14, 11. Máhi is also used in the sense of *habitually*.

máki, má*χ*i; see máhi.

ma mō'man *therefore, on that account* 8, 21.

man *there, at that place* 8, 19. 16, 15.

mántaläs, mándaläs *I surpass, exceed in* something.

ma-ómof, ma-ó'hmof; cf. mómof.

Maskóki, Maskō'ki, nom. pr. 1) adj. *relating, belonging to the Creek people*, or to the *tribes* forming their confederacy; ísti Maskóki *the Creek people* 8, 1. 2. 7. 18, 6. On the origin of the name, see i. 58–62. 2) subst. *Creek, Muskogee Indian;* also ísti Maskóki, coll. ísti Maskokálgi *the people of the Creeks.*

máta, pl. matági *the same, the identical one; he himself, they themselves.* matā'git ō'mis *they do it themselves; they are the cause of it.*

matapóma'lis, for mátawa óma'lis *will* or *must be the same* 16, 35 (*w* changed to *p*).

má'la*χ*ka, pl. ma'lá*χ*'laka *different, sundry, various* 10, 9. 26. Cf. tcha'hmiläíga.

mátawa, matawa-ú'h (pl. same) *the same also, the same too.*

mátawan *at the same place* or *spot also* 8, 23. Refers to places in close proximity: *at that same spot* 14, 18.

ma-úkid 16, 11 for ma úkid; see óki.

mä-í', adv. *yonder, over there, out in that direction;* involves the idea of choice or preference. mäímat *or* mä-í mat (the white path) *yonder* and not the other 18, 11.

míko, míku (ĭ' short), míkko, pl. míkagi, coll. míkalgi *chief, chieftain, leader* (míngo in Cha'hta) 8, 9–15; cf. i. 58. fúsuă ómal immíkkun *the king of all birds* 12, 25. púmmikût *our chief* (or *chiefs*) 18, 1. míkko 'láko *the king of Great Britain* 18, 13. ímmiko, subj. ímmikut *his chief, their chief or chiefs* 8, 3. 8 etc.; cf. i. 156. 161.

míko huyanídsha the cylindric brown root, 2–3 feet long, of a shrub, probably Salix tristis; cf. Commentary. The root was and is still in use as an astringent (not as a purgative), and in the text is referred to as "red root" 10, 28. 30; cf. huyánäs.

mitikáyäs, for im-iti-káyäs *I push down, throw down for somebody.*

Mitikáyi nom. pr. of a war-chief of the Okóni tribe of Lower Creeks. "Pushing-down"; in text. Mittakawye. Der. mitikáyäs.

mó'hmat, mú'hmat same as mómat, but referring to a *past* tense: mú'hmati atígad *since then, up to now* 18, 1.

mó'hmen, mó'hmit, mú'hmen same as mómen, but connecting verbs standing in a *preterit* tense 8, 5.

mō'man, see ma mō'man.

mómat, mómad, múmat conj. introducing a causal connection with the foregoing: *and then, in that case, under these conditions; and if; if then.* múmat nĭ'ta ō'dshin *and there being such a day* or *time* 8, 18. múmat-in 1) *and then* 10, 4. 16, 6. 2) *because.* mómadit *and since, and because* 16, 8. mû'madit *because* 16, 10. Lit. "it being so." Der. ma, ómäs.

mómäs, múmäs 1) *but, however* 8, 22. 23. 10, 13. 15. 2) *although.* 3) *I do so, I act thus;* hían múmikun û'mad *if they do not perform this* (fasting) 10, 36. múmaχan, múmakan *if we act so, do so* 8, 24. Der. ma, ómäs.

mómen, mómit *also, too; and, hereupon, then;* connects sentences, not single words 8, 5; mō'mi istómäs *nevertheless* 16, 5; also múmitu istómäs 8, 24; -u at the end of múmitu being an additive particle. mómin ómad *whenever they did so* (fasted) 10, 33.

mómika, múmika, contr. múnga *therefore*, lit. "for doing so" 14, 18. 38. Der. ma, ómäs, -ka.

mómof, mómofa, múmōf, ma-ómof *then, at that time; hereupon.* ma-ómofa máhin *about that same time* 10, 38. mó'mof, mó'hmōf, mú'hmof *hereupon;* referring to past, historical events only. mú'mof *but then* 8, 20. hía nági mú'hmōf íyupan *when this thing had occurred, after that* 12, 31; contr. from ma ómofa, "when that was thus."

mónks *it will not do* 14, 11; contr. for mómiku ō'mis.

Mō'terell nom. pr. of a mountain. The name in this form is not Creek, there being no *r* in the Creek language. 16, 10.

mótcha, mútcha *now, at present.*

motchă'si, pl. mótchasagi *new, newly made.* Der. mótcha.

mótchatat *now, at present;* lit. "now that is." Der. mótcha.

mú'hmof, mó'mof; cf. mómof.

mumídshäs *I do this, I act thus;* the causative of mómäs, q.v. mumí'htchid *after doing so, when we have done that* 12, 3 (*'h* sign of past tense). momítchita kómit *trying*, lit. "wanting to do so" 12, 7.

múmaχan, see mómäs.

múmitu istómäs *nevertheless* 8, 24.

múnga 14. 18. 38; see mómika.

muntúmäs *although it is so* 18, 9; contr. from mómit ómäs.

náfkäs, pl. of subj. náfkis, pl. of obj. nafnákäs *I strike, hit; I beat*, as a drum. nafhúgis ma úkid *alike in sound* as when *they beat* (a drum) 16, 11; cf. i'lanáfkäs.

náhunña, connective particle, used by speakers for filling the pause necessary to think over new sentences: "come up!" corresponds to Hitchiti nánga'hmi, nángaχmi.

náki, nági, nä'χi; pl. nánaki 1) pron. interrog. *what? which thing?* 2) pron. dem.-relat. *that which, the thing* or *things which; what, whatsoever.* náki Tchikílli opunáyatis *what Tchikilli has related* 8, 2. 3. nákitoha *whatever it might be;* explained by nákit ómi hákis "what it was made to be" 10, 1. nágitun ō'mad *whatever it is;* contr. from nágit ómin ō'mad 10, 3 (-tun is suffix). 3) *thing, object;* in some instances also applied to animate beings, people. ma nákî *that object, thing* 12, 16. nák' omálga *everything, all objects* 12, 32. hía nági mú'hmōf *after these things* 12. 31. nági *everything*, p. 60; see hí'lkusäs. nákîtäs *some object, something* 12, 18. náki yelúnga *some roots, bulbs;* lit. "bulb-things" 14, 26; nánaki *things* distinct from each other.

naχ=unáχa, nak=unáka *story, account, legend;* lit. "what they relate." innaχunáχa *their legend* or *tradition* 8, 1. Der. náki, unáyäs.

ná'lkaba *middle, half.*

nĭ'fo *beech-tree;* see Nófāpi.

níha *fat, lard, oil.*

nik'lä'dshäs, pl. of obj. and frequentative: nik'läko-ídshäs *I burn*, v. trans.

nik·lis, v. intr. *it burns;* itut n. *the stick is burning, ablaze;* tchaník'lis *I am burning*, v. intr.; cf. i. 216. nik'lúfat *when, at the time, through burning*; with the temporal suffix -ófan, -úfa 12, 2.

ní'li *night;* ní'li ómof *at night;* má ní'lin *that night, the same night;* n. timapógi *during the whole night;* n. hámgin *during one night* 14, 32.

níni, nî'nî *way, road, trail, path, footpath* 12, 34. 35 etc. níni hátki (wáki) "*white path,*" the road of peace 12, 32. 7; n. tcháti "*red path,*" the road of warfare; níni páski *wagon road, wide road*, lit. "swept road."

ní'ta, nítta *day;* nĭ'ta hámgad *in one day* 8, 29; máta ínnita *on the same day;* mómad nĭ'ta ō'dshin, cf. mómad.

nódshäs, du. of subj. nodsh'hóyis, pl. nodshédshīs *I sleep;* nódshän háyatks *I sleep until day*, lit. "I sleeping it has dayed"; nodsä'dshadīs *they slept* 12, 34. 14, 33.

Nófsāpi nom. pr. of a stream: *Beech creek.* Nófāpi ká-etchid *called Beech creek* 14, 24. Der. (Hitchiti) nófi, ápi.

not'hófan *indoors, within the lodge.*

nukmíläs *I swallow.* Der. in-, uk-, míläs.

nukmílga *something to swallow; a drink.*

-o, -o'h, -u, -u'h, -wa, -wa'h, conj. *and, also, too, besides.* In our text we find it always as a suffix in íta-u, lámhi-u, má-o, mátawa; and inflected by case in adsuleídshitût *the most ancient* 10, 38; tútka tchá-atitut lánit *a fire red and yellow* 10, 17; ito-ú'h mátawat *of the same wood also* 10, 25.

ō'dshan adv. *where, at such a place;* verbal of ō'dshis. tútka óssi ō'dshan *at the place where the fire came out* 10, 10.

ō'dshäs. 1) *I have, possess, keep,* referring to alienable property; ō'dshid ómatis, pret. *he had*, lit. "having he was so" 12, 22; ódshikoka *as they had not* (-ko *not*, -ka *because*) 14, 26; ō'dshid ómatīs *he was having them* 12, 22. 2) v. impers. ō'dshis *it is there, it is where;* or, if temporal, *it is then, at such a time, at which time.* Often used frequentatively or usitatively: ō'dshit ómen aklatgátin *where* the sun *is setting* (habitually) 8, 18. 19; o-íwa u'hlátkid ō'dshin *where water is* or *was falling* 14, 33; ō'dshit ō's, contr. for ō'dshit ō'mis, *so it is there* 10, 19; yahá-iki ómäs ódshid ómīs, lit. "so it is there singing-like"; *it still* emits a sound *like singing* 10, 19; 'láni ahítki ō'dshi *that was burning there on the mountain* 10, 18; ódshin *being there* 16. 14. 15; talófat odsatchúkit *concluding that a town is there* from the smoke seen 16, 28. 29; cf. ómadshuks under ómäs. Temporal in: níta ódshin *there being such a day* or *time; at a certain time* 8, 18.

ōdshípäs *I possess, keep, have;* the ō'dshäs with medial suffix -ip-; kómakatis ódshipin ómad *they supposed that in case they should keep it* 12, 17.

ō'dshis, v. impers.; cf. ō'dshäs 2).

ō'dshit ōs, cf. ódshäs.

ófan, úfan, apoc. ófa, -of, -uf, local and temporal partícle connected mostly with verbals: 1) referring to the place wherein: *inside of* some locality; *within.* Cf. Odshi-apófa, lit. "in the hickory grove"; talófa *city, town.* 2) referring to the time *when* a fact occurred: *inside of* a lapse of time; *when, at the time of;* cf. át ófan, under átäs.

o'h-, ok-, oχ-, prefix; see u'h-, uk-, uχ-.

o'hlítkäs, u'hlítkäs *I run up to;* o'hlitäígit ígan=haúki *running towards the pitfall* 14, 13. Der. lítkäs *I run.*

o'hlómhin, cf. o'hwákäs.

o'h'lolopi *year* 14, 2 etc.; *during, in the year* 8, 4; u'h'lolopófa *when a year had elapsed.*

o'hwákäs, u'hwákäs, du. of subj. o'hwak'hógīs, pl. o'hlúmhis *I lie, am lying on, upon;* man o'hlómhin *lying there* on the rocks, speaking of more than one subject 16, 16.

o-i='láko, ui='láko *river,* lit. "great water." This is sometimes applied to large sheets of stagnant water. Der. o-íwa, 'láko.

o-i=okúfki, u-i=ukúfki 1) *muddy river* cf. 8, 27. 2) O-i=kúfki, Uyukúfki nom. pr. of the *Mississippi river;* 'láko *great, large,* being often added to this name. 3) name of several small muddy water-courses, and of villages built upon these. Der. o-íwa, okúfki.

O-itúmka "*Sounding Waters,*" nom. pr. of 1) Wetumpka, a town in Central Alabama on Coosa river; 2) in the text Owatunka refers to a brook, now called Big Yuchee creek, running into Chatahuchi river from the west; 3) name of a post-office in Creek Nation, 40 miles west of Yufála, Ind. Terr. Der. o-íwa, túmkis.

o-íwa, u-íwa, úyuwa, oi-ua in compounds abbrev. ó-i, ú-i: 1) *water, liquid:* drinking-water, standing water etc.; ú-i-hat-ki *ocean*, lit. "white water"; ó-i-'láko *river*, and any *large water-sheet;* uíwa tsá-ati *red water.* 2) *running water, river;* oí-ua okúfki *muddy river*; uíwa tsá-ati *red river* 8, 29; wi-kä'wa *spring;* úyuwa 8, 32.

ókäs, ó*χ*äs 1) *I emit such a sound* or *voice; I say, tell so, announce, convey such news;* opunáyit ókatis *he spoke as follows* 8, 17; ókātit mákatis *announcing they told, related* 14, 3. 4. 2) *I do* or *act so, in such a manner;* refers to sound or utterance only.

ok'holáti, o*χ*'huláti, okuláti *blue* 10, 14; *dark blue* and *light blue;* ok'holátid ómis (the bones) *are blue* 14, 16.

óki, úki, pl. ókagi *alike to in voice, sound, utterance;* lit. "sounding thus"; a verbal of ókäs, q.v.; tinī'tki ō'kin *sounding like thunder* 10, 1; yahaíkida ókid, ókit *something like singing* 10, 3. 5; ómātit ókin *being alike in its noise* or *sound* 10, 2; lámhi ókit *voiced like an eagle* 12, 30; ma úkid hákit ómīs *sounding like this it makes a noise* 16, 11.

Okmúlgi, coll. Okmulgálgi, nom. pr., *Indian of the Ocmulgee tribe*, originally on the river of the same name, Georgia, afterwards on Chatahuchi river 8, 13. The name is explained i. 140.

okúfki, ukúfki *muddy* 8, 27.

Okúni, Okóni, coll. Okúnalgî nom. pr., *Indian of the Oconee, Okúni tribe*, originally on Oconee river, Ga.; afterwards on Chatahuchi river 8, 12.

o*χ*'huanápsäs, uk'honápsäs *I am the offspring of, descend from;* ma o*χ*'huanápsid ómīs *from these he draws his origin* 16, 31; cf. huanápsidshäs.

ó'läs, ó'lä-is, ú'läs, dual of subj. o'lhóyīs, pl. o'lhäídshīs, u'läítchis (from u'lyédshīs). 1) *I reach to, come up to; I arrive at.* o'läítchatis *they arrived, came there* 12, 32. 14, 31. 16, 7. u'läítchatis (same) 14, 21. 34. 35. u'lé'htchadīs (same). u'läítchadin *arriving* 14, 37. u'lé*χ*tchît *having arrived there* 8. 28. 2) impers., ó'lis *it elapses*, said of time; oχ'lolopí óstad ó'ladis *four years passed, elapsed* 14. 3; ó'lin, postp., see below; cf. i'ló'läs.

ó'lin, postp. *up to, so high as, so much as;* hayómat ó'lin *until this day*, p. 60; ni'ta kulapáχäs ó'lin *or up to seven days* 10. 35; cf. 14, 18. 23; níta ō'stin ó'lid *as long as four days;* níta ō'stin ó'lof *when four days were reached.* Lit. "reaching up to." Der. ó'läs.

ō'ma, adj., chiefly used as suffix: *alike to, resembling.* yahá-iki ómäs (for óma-äs) *like singing, as if it were singing* 10, 19; imáhilissua ómäs *such things as medicines* 10, 11. ómātit *for being alike* 10, 2. Appears also in the Cha'hta haktchúmma *tobacco*, cf. i. 58, and in míko-ō'ma i. 199.

ómal, see omálga.

omálga, úmalga, abbr. ómal 1) *every, each* 12, 14; o'h'lo-lopí omálgan *every year, yearly* 10, 31. 2) *all;* umálgan *all persons* 16, 26; ómal immíkkun *the king* or *chief of all* 12, 24. 3) *the whole of; whole, entire, in bulk.* omálga máhi *entire* 14, 11. Der. ō'ma, -algi.

ómat, û'mad(i) *when, if;* cf. mómäs. Cf. i. 206 (paradigm). ódshipin ómad *if they kept it* 12, 17; hían múmikun ú'mad *if they do not act, perform so* 10, 36; û'h'lánin ómad *if would cover* 12, 5. Der. ómäs; cf. mómäs.

ómäs, pl. of subj. omóyīs, umhóyīs 1) *I do so, act in this manner; I accomplish; I am the cause of.* ahudshífit um-hóyadīs *they were wont to call it*, lit. "they did so nam-ing it." tchíntagit (or tchímit) ómadshuksh *ye do it your-selves* (2d pers. pl. present); ómadshuksh (for omatchúkis) kómatis *they believed they were the cause of it* 16, 17. 30. the suffix -tchúkis, -tchoks pointing to an act reached by conclusion only and done at a distance; also in ómadshōks kúmhuid ómīs *it was believed were the cause of* that noise 16, 12; 3d pers. pl.; cf.. i. 209. 2) *I do so habitually, I am in the habit of;* ómīd ómitanks *it habitually occurs*, lit. "it is wont to be so" (-tankis, -tanks is also of a usi-tative meaning); isiafástid ómants *they habitually admin-ister it to themselves* 10, 31: ístin pumpasátit omítutanks *he was in the habit of eating our people* 14, 4. See also 1), first quotation. 3) *I am so, I am such* (habitually or not); *I am alike to;* cf. the paradigm i. 209. ómīs, contr.

ō's, ós, -us *so he, it is, thus it was,* or *has been* 12, 28; átassa ómid *being like a war-club* 10. 24; omáχadis *they were such* (flatheads) 16, 25; tchátad hó·lit ómin *the red being war*, viz. "like war, meaning war" 12, 28. 4) In most instances ómäs stands for our auxiliary verb *I am*, though the idea of *I am so* is always understood to be underlying; as an auxiliary verb, ómäs forms, appended to verbals in –t and –n, a long array of periphrastic conjugations, active, passive, etc.; and also a number of conjunctions, like mómen, múmof, ómäsim, ómika, ómofa etc. Lámhi-u míkko 'lákid ō'mis kómagid ómis *they think that the eagle also is a great king* or *chief;* lit. "the eagle also (-u) a chief great so is, thinking (kómagid) they are (ómis)," the second ómis being the auxiliary through which kómagid is conjugated 12, 25. 26; ístit fúllangîd ō'mis kómatīs *they believed them to be the very people* (formerly engaged in making the white path) 14, 37. 38; ísti hí'lágit ómin ómad *whether the people were good* (or not) 14, 39; atchúllid óma'lis *it will be old*, viz. the oldest, most respected 12, 5; máta óma'lis *it will be the same*, or *like the same;* isámumid-es ó'hmis *that it might be better so* 12, 36. 37; látkid ómit *alighting there* 14, 32; ísti istómid fúllit ómati *what people had been about there* 12, 36. cf. 33; isihí'li ómati *to be the better thing* 18, 11; níni istómid ómad *what sort of a path it was* 12. 35; úχui·lit ómatit *was standing there*, lit. "was so as to stand erect" 10, 20; istukä'-idshi máhid ómatin *although it was very noisy* 10, 21; ísti istómit omákat (verbal, -ka causal suffix) desirous of seeing *what kind of people they might be* 16, 5; omídatit-äs istúngun *although he was* 18, 12.

ómäs, adj., *alike to*, in 10, 11. 19; cf. ō'ma.

ómäsim *although it is* 12, 2. 18, 10; *although they are* 12, 7: is conjugated through all persons: omáχäsim *although ye are.*

ō'men, ómin 1) *there where, where;* ō'dshit ō'men aklatgátin *where habitually is setting* 8, 19. 2) *there;* same as the adv. man 10, 5.

ómika, óměka, úmiga, contr. û'nga 1) postp. *because;* háyatit ómika *because they made* 18, 8; íkodshid óměka *on* *account of the smoke* 12, 39. 2) conj.: *on that account, therefore:* akasamágid óměka *believing it on that account* 18, 15. Der. ómäs, -ga.

omítchäs, pl. of obj. omitchä'dshäs *I continue, keep on;* imomitchä'dshin *continuing* in regard to *itself* (reflective function of im-); is connected with a verbal in -t (-d): înlóχatid *to devour from them* 8, 25. Der. ómäs 1).

opánga *dance.* The various dances performed at the busk festivity are mentioned i. 177.

opunáyäs, abbr. punáyäs *I talk, speak, converse with;* hammä'kit opunáyatīs *he spoke thus, he related as follows;* lit. "this saying he spoke" 8, 3; oponáyat *him speaking* 18, 14; imponáyatīs *they spoke to them* 16, 34; impunä'yipat *talking to them* (-ip- medial voice, p. 60); opunáyit ókatis *he spoke thus,* lit. "he sounded thus when speaking" 8, 16. Der. unáyäs.

ōs, ō's, os, contr. from ō'mīs, ómis; cf. ómäs.

ósotchi, Ósutchi, Úsutchi, coll. Osótchalgi, nom. pr. *Osotchi Indian* of the Lower Creeks 8, 14; the town still exists in the Indian Territory, consolidated with Chehaw (Tchíaha) and counting about 25 persons in 1878; situated about 65 miles N.W. of Yufala.

óssati, óssāti *rising;* only used in connection with hási: hă'si-óssati *in the east, at the place of sunrise,* lit. "where the sun issues" 8, 26. 10, 13. Der. óssäs.

óssäs, ósäs, du. wúlgis, úlgis, and wulhóχkīs; pl. sóssis, sósīs, isóssīs *I come out, issue from;* óssi ō'dshan, lit. "at the place where it comes out" 10, 10; 'lánin óssît *rising out of a mountain* 10, 2. wulhokχäíta or wulhokχä'-ita (-ä-it, -ät) *we two came out of, left, seceded,* p. 61. Cf. a-óssäs, i'la-óssäs, i'lóssäs.

ósta, nom. pr. of Ousta, míko of the Kasí'hta Indians 8, 9. Explained in Commentary, p. 27.

ō'sti, ósti, ústi *four* 10. 26; itáluat ō'stîga *as there are four tribes* 12, 1.

páfnayīs, pl. pafpaníyīs *I am swift, nimble* (in running, flying etc.); páfnīs *he is swift, quick;* páfpanīs *they are swift.*

páfni, pl. páfpani *swift, quick,* said of animals, arrows etc.; forms no adverb.

páfnita *swiftness;* ímpafnita *its swift flight* 12, 14.

páhi *grass, herb;* páhitäs *even the grass* 12, 32; páhi táli *dry grass.*

paídshidshäs, pá-etchitchäs *I follow up* a creek, path, road; paítchitchi *one who follows up* (as above), *goes along* something *laid out;* cf. adshakáyäs.

paíkäs, paígäs, du. and pl. atíkīs, atíχīs, pret. atíχgīs *I am inside, within;* tchátu haúkin paíkīd *staying in a cavern* 14, 3; paíkan *when lying inside* 14, 9; cf. apaígäs.

pakā'dsha, or ísti pakā'dsha *leader; leader in war, commander* i. 165, 186.

pákpagi 1) *lather, froth, scum* of water or other liquid; 2) *bloom, blossom, flower,* p. 45.

Palaχtsúkla, coll. Palaχtchuklálgi, nom. pr., *Apalatchúkla Indian,* of Lower Creeks 16, 30, 38, 39; cf. 8, 10.

pala=hámgad, palhámgat, palhámgit *one side of, one half of* 18, 9, 10; palhámgad tcháti *red on one side of it,* etc. 14, 15.

pala=hámgan, palhámgan *on the other side of,* referring to the spot occupied by the one speaking: 'láni, tchĕ'χu pal=hámgan *on the other, rear side of the mountain, house.* The above form is preferable to palhámgin: ú-i='láko pala=hámgin *on one side of the river* 18, 3; cf. apálui, tapála.

palátka *the shedding, spilling;* tcháti palátka *the shedding of blood* 16, 32; cf. látkäs.

páli, abbr. pál, pal *ten;* in counting objects abbr. to pá, cf. i. 202; páli=hokólin *twenty;* páli=tut'tchínin *thirty* 8, 4, 16.

pápäs *I eat, feed on,* the food being of one kind only; 'lá'lun pápît *eating fish* 8, 31; ístin pápît *devouring persons, men* 12, 15; cf. hómpäs, lóχäs.

pasátäs, cf. ilídshäs.

pā'ssa *button-snake root* 10, 28.

po-, pu-, prefixed pron. poss. of 1st pers. pl. *our, ours;* pónho·li *our enemy in war* 12, 3; pófigi *our hearts* 16, 34; púmmikût *our chief* 18, 1. The prefixes pon-, pun-, pum- are combinations of pu- and in-, im-.

podsû'shua *ax.*

podsú'shuàdshi *little ax, hatchet;* in text "tomahawk," although the átasa is meant 16, 35.

pófigi *our hearts* 16, 34; see ífigi.

póhäs, pl. of obj. pohákäs *I hear, listen to;* impóhatis *they heard* (its noise, im- pointing to *its*) 10, 1; the singular may be used when tribes or bodies of people form the subject of the sentence, but pohákatis is preferable and stands 10, 3. pohágît fúllid ómis *they are hearing it* 16, 13 (verbal, 3d pers. pl.) pohágidut *hearing, listening to* 18, 14.

póki, pógi, púki *last, ultimate;* cf. ispógi, puχgákin.

pō'χki *noise, disturbance in the air;* lit. "what is heard"; 16, 13; verbal of póhäs.

pómi, púmi *we, ourselves;* pómî-û *we too, we also;* púmit ókis *we* (and *we two*) *say so;* pómit ō'mis (for ō'mi-is) *we are the cause of it, we do it.*

pō'skäs, púskäs *I am fasting;* ípuskis, abbr. from i-apō'skis, *they fasted,* said 10, 33 of women menstruating, who then abstained from salt and meat; pō'skat *when they fast, during fast* 10, 30 (verbal); imapóskäs *I fast in a certain intention;* cf. i. 209.

puyáfiktcha, puifíktcha *ghost, soul, spirit;* lit. "our spirit." The old Creek notion is that at death the spirit goes the way the sun goes, to the west, and there joins its family and friends who went before it—the words of a Tukabatchi chief; Hawkins' Sketch, p. 80.

Puipa-édshi, nom. pr. of a Creek chief of the town of Apalachicola 8, 10; cf. paídshidshäs.

púkabi, púk=api 1) *pole on ball-ground* to throw at with balls (púku). 2) *pole* of any kind, flagstaff, &c. 10, 20. 23. Der. púku, ápi.

púknaka *nest of bird;* also *bed* made by some animal, as a hog.

puχgákin *on the top of it, for closing up;* adverb serving as expletive to close up large numbers 8, 5. Der. póki.

pum-, pun-, double prefix; see po-.

pumpasátit, cf. ilídshäs.

punáyäs, abbr. from opunáyäs, q.v. imponáyatis *said, spoke to them* 16, 34. Der. unáyäs; cf. i-unáyäs.

pusidshä'dshäs, pl. of obj. puskakúidshäs *I make fast; I cause to fast for initiation* i. 186. Der. pō'skäs.

púskita, pō'skita 1) *fasting, fast.* 2) *festival of fasting, annual busk* 10, 31; called so after a fast preceding it. Described i. 177–180.

sabáklis, sapáklis; cf. huiläs.

sahokóla (for isahokóla) *second* 10, 28.

sá-oka, sá-uku, saúga *rattle* 14, 8: *gourd-rattle* of conjurers, dancers; cf. i. 14. 143.

sásis, sásatis; cf. isá'läs 3).

sáta *persimmon;* sát=api *persimmon-tree;* sáta 'láko *apple.*

satut'tchína, contr. satutchína *third* 10, 28.

sa-ústa, sa-ósta, isa-ósta *fourth;* isústad for isa-ū'stat, lit. "the fourth of these" 10, 29. Der. ō'sti.

sawátsku'h, in text "sowátchko, which grows like wild fennel" 10, 28; cf. Commentary, p. 44.

Sawā'na, nom. pr. of Savannah, sea-port in Georgia 8, 3.

Sā'wokli, coll. Sāwoklálgi, Sa-uklálgi, nom. pr., *Sáwokli* or "Swaglaw" *Indian.* They formed a Lower Creek tribe on Chatahuchi river, and are now in the Indian Territory consolidated with the Hitchiti Indians. Cf. i. 144.

sä-ídshäs, säídshäs *I give birth to.* Der. hídshäs; cf. hitchkuídshäs, káyäs.

sihō'kis, shihókis; sihóχät, p. 60; cf. huiläs.

siyukfanídshäs, pl. of obj. siyukfanfayídshäs *I place at the end* or *top of,* when the object is near; si(n)yokfanfa-édshit *pointing more than one* arrow 14, 28. Der. isi-, i-, úksa, fanídshīs *it projects, sticks out.*

sin, -sin when suffixed to adv. and adj., *very, quite;* anákuasin *very near to* 8, 20. When prefixed to adjectives sin-, isin- forms comparatives.

siwanákita *belt.* Der. iwanákäs.

sigā'tis *there was not;* istä'mat sîgátis *nobody was there* 10, 21. 22. Der. ísäs, -ku.

=síko, =sígō; see =súsiko.

Stimalagué'htchi, nom. pr. of a chief of the Osotchi tribe, called in text Stimelacoweche, "one who brings to somebody" 8, 13. The full form is "ísti=imalakúidshi. Der. ísti, alakúidshäs.

stillipaíχa 1) *moccasins;* cf. i. 185. 2) *shoes.* Der. ísti, íli, paíχa; lit. "somebody's foot to be within."

súlgi, súlki *many;* ísti súlgad *a large number of people* 8, 23. Der. álgi.

súmgipi, pl. súmitchipi *lost, gone;* in text "deserted," the term houses being omitted in Creek: "and on arriving they were gone" 16, 6. súmgips, contr. súmgips, súngis *he is lost* or *dead.*

sumitchä'dshäs, pl. of obj. sumhúidshäs *I lose;* cf. i. 186.

=súsiko *not possessed of, not having;* from si-usi-kō, -usi being a sort of hypocoristic, fondling diminutive ending, instead of the usual =síko, =sígō *having not, being without; absent.* Both are used only when appended to nouns and nominal forms. í'tski=súsikōn *motherless* 10, 22. Der. ísäs, -ku.

tabála, see tapála.

tádshäs, pl. of obj. wá'läs and wutchótäs *I cut off, sever, separate;* kalágit intádshäs *I cut off for* somebody *by gnawing* 12, 23; cf. tuwá·lki; tadshä'kin (my finger) *cut off,* p. 60.

táfa *feather;* táf=atki, contr. from táfa hátki *white feather* 16, 39.

táyi, táyis, abbr. from -titáyi, titáyis, q.v.

táyikäs, täíkäs, du. of subj. tayihókīs, täihógīs, pl. tayídshis, tä'-idshis *I cross,* as a river; ma hátsi tayíχtchit *having crossed that stream* 14, 1: χ-, h- is the mark of the preterit; also 14, 36. täígagi titáyin háhi-it *they made it fit, adapted, sufficient for crossing* 16, 24.

tak-, taχ- prefix: *on the floor, ground, soil;* cf. takitídshäs.

takitídshäs *I build a fire on the ground* or *floor;* cf. ahitídshäs.

taklä''htchäs, du. of obj. takáhiäs, pl. takapóhiäs *I lay down, deposit on the ground;* said of round and bulky objects.

takläídshäs, du. of obj. tak'káyäs, pl. takapóyäs *I keep* somebody *sitting,* or *staying at home;* ták'kāyäd *two residing,* lit. "kept sitting" p. 60, 61; dual form, because a tribe or gens is spoken of.

takwakídshäs, du. of obj. takwak'hukä'htchäs, pl. taklumhä'dshäs *I lay down, deposit on the ground,* said of long or solid objects; takwagi*χ*tchit *having thrown away* 16, 36. Der. wákäs.

takweíkäs, pl. of obj. takpalátäs *I throw on the ground.* Der. tak-, waíkäs.

tá*χ*adshui, tákadsui, pl. takátstawi *hard and brittle*, as untanned hides; cf. wánhi.

-tá*χ*ti, -tá'hti, see -tati.

talepó'la, coll. talepu'lálgi *stranger* 18, 12.

talófa *village, town, city* 16, 21. 25; refers to the area or houses, while tálua refers to the inhabitants: Sawā'na talófan *in Savannah city* S, 3; Kósa talófa 14, 23; talófat ódshin *a town lying there* 16, 20. Der. tálua, -ófa.

tálua, táloa *tribe, town, common settlement, village, "nation"*; itálua *his, her, their tribe* or *town* 18, S. etc.; ísta itálua *which nation or town* 10, 38. ísti itáloa *people of* (different) *tribes* 10, 9; cf. talófa.

tamamápka, see a'lkasatúlga.

támgäs, du. tamhógis, pl. tamídshīs *I fly.*

Támhuitchi, nom. pr. of a "dog-chief" called Tomehuichi in text S, 11; cf. tamidshä'dshäs.

tamidshä'dshäs, pl. of obj. támhuidshäs *I cause to fly, I stir up*, as one bird (fúsuan) etc. Der. támgäs.

Támmidsho, nom. pr. of a war-chief of the Kasi'hta Indians: "Flying"; referring to a plurality of subjects, probably of birds or insects S, 9. Der. támgäs; cf. támhuidshäs.

Tamodsä'-idsi, nom. pr. of Tomochichi, míko of the Yamacraws, who had separated from his tribe, the Apalatchukla, and retired to the mouth of Savannah river; lit. "one who makes one bird fly" 16, 31. Der. tamidshä'dshäs.

Tamókmi, nom. pr. of a war-chief of the "Eufantees": in text Tahmokmi S, 15.

tapála, tabála *on the other shore*, or *side of; across* 16, S. hátchi tapála *across a stream*; tapála 'láko (for u-íwa 'láko) *across the ocean.* Der. iti-, apála'h; cf. pala-hámgat.

tapíksa-īs *I am flat, level*; tchákat tapíksīs *my head is flat*; púkat tapíkstagīs or tapíkīs *our heads are flat.*

tapiksä'dshäs, pl. tapikstakúidshäs *I render flat, flatten*; tchákan *my head*; íkan *his, her head.*

tapíksi, pl. tapíkstagi *flat, level, even;* cf. tutapíksi; *flattened* 16, 25.

tassikáya 1) *warrior;* 2) *citizen;* antasikáya *my fellow-citizens*, p. 60.

tássasana *kingfisher.* Men dressed in the skin of a kingfisher (t. há·lpi) accompanied every war-party, and had to supply the warriors with water.

-tati, for the past tense -tá'hti, -táχti, suffixed to nouns, etc. 1) *first in time, previous, prior to:* asa-táti *that yonder first;* ísta italua-tátit *whichever tribe would be the first to* .... 12, 4. The past form: Kasíχtalgi-táχtit hídshatit ómit *because the Kasi'hta Indians saw first* 18, 7; see also 12, 7. 2) *ancient, defunct, departed, gone:* adshulagi-táti *the defunct forefathers* 8, 1.

-táwa, in adverbs -táwan, suffixed to nouns and pronouns, &c. 1) *same, identical;* mátawa *the same;* hiátawan (and mátawan) *at the same place* 10, 26. 2) conj. *but:* Abiχka-nagitáwat *but the Abikas* 12, 11; ísti tsáti yámassit ōs, inâ-hatkitáwat mû'ngot ōs *the Indian is friendly, but the white man is not.*

täígagi; see táyikäs.

-täs, -tēs, suffix; see -äs.

timapógi *complete, whole, unbroken;* cf. ní·li.

tímpi, *near;* itímpi *close to it;* cf. i. 14.

tímpuidshäs, apher. from itímpuidshäs *I approach close to him, it.*

tinítki *thunder;* tiní'tki ókin *something sounding like thunder* 10, 1. Der. ítkis.

tín'lawa *between, betwixt* (two objects); cf. án'lawa.

tipáka, tipā'ka *both together, both;* hían tipágit *we two;* lit. "both who are here"; hían típakadskat *ye two here;* ísti Maskō'ki Hatchapála'h Hatcháta tipā'χad *both the Upper and Lower Creeks* 8, 2. 3. 7. 18, 6; tibáχad *combined* 8, 13. Verbal of itipákäs, q.v.

-titáyīs, abbr. -táyīs, verbal suffix which forms a mode expressing possibility, potency, ability of doing something; also sufficiency. ayiko-titáyin háyäs *I put him in such a condition that he could not go* (-ko- *not*); adshákayigō-titáyin *being unable to follow* 14, 7: -tidáyin 12, 23; see isi-imanäídshäs;

isi-titayipialis, cf. ísäs. shihóki-titáyiha *can they stand, hold forth?* (-ha being interrogative) 10, 39. täígagi-titáyin *sufficient for crossing, so that they were enabled to cross over* 16, 24. í'lgi imilidshagi-táyad (how) *they could* or *might kill his father* 12, 20. 21. 3) titáyi, abbr. táyi, is used with a substantive in wátulat-tidáyit, "a sufficiency of cranes," viz. *a multitude of cranes* 14, 31; *enough, just so much*: atíkusi-táyin *just sufficient to reach up to* 12, 12.

tiwa 1) ***hair, hair of head; 2) scalp with the hair on;*** vol. i. 213.

tóyäs, túyäs *I belong to, I am of;* abbr. from matóyäs; í'lki-túyäs, í'lki=tóyäs *I am the father of,* q.v.; itálua tóyayad (verbal) *to the tribe* or *town to which I belong,* p. 60. This probably refers to the white or peace-towns, itálua=míkagi, also called hátki pudsháshagi, "masters of the white," or hát'haga, a collective subst. formed from the plur. of hátki.

to=lopótski, tu=lupútski *branches, small wood or sticks* 14, 7. Der. itu, lopútski.

tó·lkua, tú·lkwa *knee;* ísti=tó·lkua *a man's knee* 12, 11.

tótka, tútka *fire* 10, 13–19; contr. from ítu, ítkis.

túba, túpa, tópa 1) *bedstead;* intubá (i)lídshan *under their bed* 16, 38; the *mat-seats* in the "great house," vol. i. 172. 2) *scaffolding:* túpan uχ'háyäs *I erect a scaffold.*

tu=falápki, pl. tu=falá'hli *split rail.* Der. ítu, falápäs.

tukáχlidshäs *I split;* kúha tuká'hli *split canes* 14, 29. Der. ítu, káχlidshäs, pl. form of kádshäs *I break.*

túläs, tóläs, pl. of obj. túltuidshäs 1) *I cut down, I fell;* ítu haúkin túlhuis *he cut down a hollow tree;* ítu hauhákin tultuihódshis *he felled hollow trees.* 2) *I push down.*

túlpuyäs, pl. tulpútuidshäs *I draw the limbs or legs up; I double myself up.*

túmkis, v. impers., *it rumbles, resounds* like falling water; onomatop.; o-íwa túmkis *the water resounds;* cf. O-i=túmka.

tû'n *being thus, being that way;* contr. from ómit ō'min: 10, 3. 14, 15. Tamókmi kapitáni tû'n *Tamokmi being war-chief* 8, 15.

tupá·la, túpa·la *in the rear of, behind;* tchúku túpa·la *in the rear of the house;* cf. yúpa.

tú=pĕlúksi *round shield;* lit. "round wood," vol. i. 223. Der. ítu, pulúksi.

tustanóki, coll. tustanoχálgi, tastĕnoχálgi *warrior* 8, 16; in Cha'hta: túska.

tu=tapíksi *plank, board;* lit. "wood flat." Der. ítu, tapíksi.

tut'tchíni, contr. tutchíni *three* 10, 9; páli=t. *thirty* 8, 4; cf. i. 202.

tu=wáka *square* formed of four logs during encampments on a war-expedition, as if for holding council. Der. ítu, wákäs.

tuwá'lki *stick, pole;* lit. "cut wood." Der. ítu, wá·läs (under tádshäs).

Tuwidshédshi, nom. pr. of a Creek chief of the Okoni Indians; called Tuwechiche in text 8, 12.

tchafíkni, pl. tchafíndshagi *healthy, sound.*

tchafíknigō, pl. tchafindshágigō *not healthy* 10, 37. Der. ífigi, -kō.

tchahí'lkīs, pl. puhí·lkīs *I am friendly, peaceable.* Der. hí'li; cf. hí'lkayīs.

tchahítchkīs, pl. puhítchkīs *I am born;* cf. hítchkäs.

tchahósîs, pl. of subj. puhósis 1) *I am lost;* 2) *I forget.*

tchayádshīs *I want, desire;* i-ádshid *desirous of* (verbal) 16, 32; cf. tchamálustīs.

tchayámassīs 1) *I am friendly, liberal, generous, hospitable, gentle.* 2) *I am mild, meek, peaceable, not warlike.* Der. yámasi *gentle.*

tchákäs, tcháχäs *I overtake, catch up with.*

tchak'hídshäs, tchakídshäs, pl. of obj. tchaktchahídshäs *I set up, plant in the ground; I stick up.* tchaktcha'hí'htchid *having set up* (four poles, &c.) 12, 1; itu tchaktchahídshati *poles set in the ground,* or *each pole planted* 12, 5.

tchaχgípi, tsa'hgípi, abbr. tchá'hgi, tsáχgi *five;* tchaχgípäs *five* objects of *such a kind* 10, 34; tchakgipákäs *each five.*

tcha'miläíga, tchaχmiläíka *different, sundry;* cf. má'laχka.

tchamálustīs *I desire, wish for;* pumálustis *we desire;* emúngats tchamálustis *I continue to desire, I am not satisfied;* cf. tchayádshīs.

tchanági *that is mine, belongs to me;* also, ánit ómäs; lit. "my thing." Der. tcha-, náki.

tchápa, tchába, postp. *to the half of; half up, half-way up* or *down* (a tree, creek, &c.) Cf. kán=tchábi.

tchapaki=hí'läs *I am very angry, irritated;* lit. "angry-good-I-am" 14, 9. Der. tchapákäs, hí'li; cf. tchapakáyäs.

tchapíngalis *I am afraid, in terror of;* cf. 10, 7.

tchapakáyäs *I become* or *am angry, wroth;* íkanat tchapáka-ikit *the Earth becoming angry* 8, 21.

tchapákäs, pl. of subj. tchabak'hō'kīs *I am angry, wroth;* tchapák'hoχadīs *they became furious* 16, 22. Intens. tcha-tchapakä'-is *I am quite mad, angry;* tchatchapă'kida má-hîs *I am very angry.*

tchápki, tchápgi, pl. tcháptchagi *long, long-stretching* 12, 13; ítu tchápki *a long, tall tree* (after falling); cf. máhi. Der. tchápa.

tchasúmkîs, pl. pusúmkis *I am lost, astray;* cf. súmgipi, sumidshä'dshäs.

tchatakué'htchit; see tchatídshäs.

tcháti, tsáti, pl. tchátagi 1) *red;* tchátid=uga *because they are* or *were red* 16, 4; ísti tcháti *Indian,* lit. "red person"; uíwa tcháti *red river* 8, 29. 32; tútka tchá-atitut lánit *a fire red and yellow* 10, 17; tsátitun for tsátit=tun *being red* 14, 15; see tû'n. ífigî tchátadi *their hearts formerly* (-i) *bloody, red* 18, 9; itálua tcháti-u *and red, bloody towns* 18, 8. 2) *blood.*

tcháti-algi, tchátalgi, pl. tchatálgagi *bloody, blood-stained;* tcháti-algátin *for being bloody* (-in, causal suffix) 16, 35. Der. tcháti, álgi.

tchatídshäs, pl. of obj. tchatakuídshäs 1) *I redden, make red, paint red;* cf. istchatídshäs. tchatakué'htchit *having painted* (them) *red* 16, 1. 2) *I am bleeding,* v. intr. 3) *I bleed* somebody: intchătídshäs. Der. tcháti.

tchátu, tchádu, tchä'to 1) *stone, rock;* tchádû-álgi *rocky, full of rocks* 12, 38. 2) *metal:* tchátu=konáwa *money,* lit. "metal beads," coins being formerly used as beads on necklaces, etc. 3) *iron.*

tcha-tchapákis, pl. of subj. putchapak'hógīs *I am* or *become angry, wroth;* same as tchapakáyäs, q.v.

tcháwä-is, tcháwäs *I take, carry, hold* more than one object; cf. ísäs.

tché, tchá expletive at end of sentences 8, 20—especially of long speeches and directed to those only who sit or stand at a distance. The meaning of this untranslatable particle is "my sentence is rounded up." Cf. tchi in i. 186.

Tchíaha, Tchíyaha, nom. pr. *Chíaha Indian.* They form a Lower Creek tribe; their name is Cheroki ("at the place of otters," tchi-ía *otter.*) A town of this name exists now in the Creek nation, Ind. Terr., q.v. Coll., Tchiyáhalgi *the Chíaha Indians* 8, 13.

tchiyäs, du. tchihúyis, pl. tchíyis and sitchíyis *I enter, go into;* cf. aktchíyäs, i'lítchiyäs.

Tchíkasa, coll. Tchikasálgi, nom. pr. *Chicasa Indian;* their tribe once lived north of the Cha'hta nation in Northern Mississippi and in Western Tennessee 12, 9.

tchíkfi, pl. tchíktchifi *thick*, said of water, liquids, boards, cloth, etc. 8, 27.

Tchikilli, nom. pr. of *Tchikílli*, head-chief of the confederacy of the Upper and Lower Creeks. At the Savannah council of 1735 he delivered an allocution to Gov. Oglethorpe, in which he recounted the national migration legend of the Kasi'hta tribe. Cf. 8, 2. 7 and Notes. His name, "making a short step backwards," from atchikílläs.

tchilásäs 1) *I rub, friction.* 2) *I shell, husk;* ádshin tch. *I shell maize;* ádshi tchilláskadi hámgin *one grain of maize shelled out.*

tchími, pron. pers. 2d p. sing. *thou;* also, *thyself, yourself;* cf. i. 203.

tchími, tchin- *your, yours,* pron. poss. of 2d p. pl.; tchíme-u *yours also* 16, 35; tchinhupuitágî *your children.*

tchimitági and tchintági, pron. pers. 2d p. pl., *ye, yourselves;* cf. i. 203.

tchíssi *rat; house-rat.*

tchóko, tchúko, tsúkû, tchĕ'χo *house, lodge, cabin, building;* tchúku 'láko *town-house, great house;* described i. 171 sqq. tchukófa 'láko *council-house* i. 174 sqq.

tchúkpi or tchúkpi hámgin *one hundred;* tchúkpi kulapákin *seven hundred* 8, 4; tch. 'láko, *or* tchúkpi 'láko hámgin *one thousand,* lit. "one great hundred" 8, 4.

tchukuläídshi, tchúko=läídshi *women, females;* lit. "those staying in the house." Used in a plural signification only. Der. tchúku, läíkäs.

tchúli, tsúli *pine-tree, pine;* tsul=íkûsûa *pine-nuts;* stands here where the text has "pine-wood" 14, 14.

tchútki, pl. lopútski *small, little.*

-u, -u'h, cf. -o, -o'h.

údshi, ódshi 1) *hickory-nut;* 2) *hickory-tree* 14, 6; cf. ófan.

-uga, -óga, -uka, suffixed causal particle: *because, since; since as it is, was, as there were.* tchútkiduga *as, because it is small;* 'lákituga *because it is large;* tchátidúga *as it is* ***red*** 16, 4. Composed of a suffix -u, -o and -ga, q.v.; cf. -iga.

u'h-, uk-, uχ-, frequent prefix: *up, up to, towards; on, upon; over, over and down on the other side; passing over.* ☞For terms not found under u'h-, see uχ-.

u'hapíhi-id, u'hapíyi; see uχháyäs (for uχ=áyäs).

u'hapíyadis, cf. uχháyäs.

u'hhayátgīs *it dawns, it becomes day, day breaks over* somebody or something; u'hhayátgadis *it dawned over them* 8, 28. Der. hátki *white.*

u'hhapiyátskas, cf. uχháyäs.

u'hläíkäs, u'hleíkäs, du. of subj. u'hkákīs, pl. uχapókīs 1) *I sit upon.* 2) *I ride upon; I ride on horseback.*

u'hlátkäs, uχlátgäs, pl. of subj. uχpalátkīs 1) *I fall upon, I fall on the top of; I fall on to.* oíwa u'hlátkid ódshin *where there was a cascade,* lit. "where there was water falling" 14, 33; u'hlatäíkin, verbal of one of the past tenses, *having fallen into* 14, 14. 2) *I attack, charge.* Der. latgäs; cf. aklátgäs, itu'hlátkäs.

u'h'lánäs, uχ'lánäs, pl. of subj. uχlomläídshīs *I cover up* (from the outside); u'h'lánin ómat *if* one of the tribes *covers it up* 12, 5; cf. isuχ'lánäs.

u'htaígäs, uχtäíkäs *I cross upon*, *I cross on the top of* (log, stones, &c.); u'htäyídshatis *they crossed it upon* (the stones) 16, 24. Der. uχ-, táyikäs.

u'htchímgäs, du. of subj. u'htchimhógīs, pl. u'htchimídshīs *I climb up to*; o'htchimhókadin *two climbing up* 16, 19.

uí-wa, see o-íwa.

úyuwa, same as o-íwa, q.v.

úksa, postp. *at the end of*, *on the top of*; 'laní úksa *on the mountain-top*; íyuksa, yúksa, i-úksa *at the end of it* 8, 32.

uχháyäs (for uχ-áyäs, u'h-áyäs), du. of subj. uχhahóyīs, pl. uχhapíyīs, u'hapí-is *I go up*, *ascend up to*; *I go to*, *approach*, *come towards*. u'hapíhiatskas (or uχ-apiyiátskas) *ye must not go up there* 16, 4; -ka in -kas includes the negative particle, and -ats- indicates the 2d person plural. u'hapíhi-id (for u'h-apíyīt) *going*, or *having gone there* 16, 3. The subjunctive mode and second person of the plural has to be supplied to this verbal by the following i'lasawa'lanátchkatis 16, 4. u'háyeyant ōs *I could have gone towards*. u'hapíyi sásatis *they went there in numbers*; *some went there* 16, 6. uχhapíadīs (uχhapiyákatis in the plural form) *they went up to*, *towards* 10, 1. 14. 8.

uχhuíläs, u'hhuí'läs, uχwí'läs, du. of subj. uχsihókīs or u'hshihókis, pl. uχsabáχlīs or uksapáklīs *I stand erect on*, *upon*; nínin u. *I stand in the trail*, *road*; púkabit úχui'lit ómatit *a pole that was so as if standing* 10, 20. Der. huíläs.

uχhutsä'dshäs, ukutchä'dshäs *I draw*, *mark*, *write upon*; uχhutsä'hudsatis *it was drawn*, *written upon* 8, 6. Der. hotsä'dshäs.

uχkáläs *I pour upon*; kasápi uχkáläs *I pour on cold water*.

uχki'lkuídshäs, pl. of obj. uχki'lkakuídshäs 1) *I make known*, *I explain*. 2) *I disclose myself to*; *I confess*. i-uχki'lkuídshit ódshin *disclosing*, *revealing by themselves* (i-) *there* 10, 27.

úχläidshäs, u'hleídshäs, du. of obj. uχkáyäs, pl. uχapóyäs *I place*, *deposit upon*. Speaking of sheets and sheet-like objects, the dual is used.

uχtalalaídshäs, o'htalalaítchäs *I lay down in order*, *dispose upon*, *on the top of* something 14, 7.

u*χ*taliksä'dshäs *I stretch out*, or *open and display*, as skins, cloth; u*χ*talikse*χ*tchit *having extended, stretched it over.*

u*χ*tútäs, pl. of obj. u*χ*tutákäs *I send out, dispatch;* ísti (for ístin) u*χ*tútatis *they dispatched people* there 10, 4.

ú*χ*ui'lit; see u*χ*huíläs.

u·lé*χ*tchit, u'lé'htchadis; cf. ó·läs.

umhóyadis 14, 32; see ómäs.

ú'musäs, postp., *such as, something like* 16, 3.

unáyäs, pl. of subj. unáyis *I tell, relate;* iyimunáhin *relating it to them* 18, 14; for i-im-unáhin. Cf. iyimunáyäs, i-unáyäs, na*χ*=uná*χ*a, opunáyäs.

únapa, ónapan, postp. *on the top, summit of; upon.* 'laní=únapan *on the top of the mountain* 10, 3. Cf. yúpan, ílidshat, úksa.

ú'nga, same as ómika, q.v.

-usi, -osi, suffixed to nouns, etc. 1) *only, but, merely;* hátkusiálgi *white only all over;* atíkusi *just up to, so as to reach* 12, 12; ísti hámkusit *only one person;* hokólusi *two only.* 2) suffix forming diminutive nouns in a hypocoristic sense. hóktusi *young woman*, from hókta *woman;* =súsiko, q.v.

waháila *south* 10, 14.

waíkäs, weíkäs, wäíkäs, pl. of obj. palátäs *I leave, quit, relinquish, abandon;* wäika'lúngo imúngat ómis *it is their disposition that they cannot quit* (-go, -gō *not*) 18, 9; waíki-is, waíkaki-is *we quit;* waika'lúnkos *I cannot quit;* wé'hkagōs *I will not quit.*

wáyäs, du. wáyi-is, pl. wáyakis 1) *I hand over, offer, present;* wéyit ómis *they are in the habit of offering* 10, 32. 'tchimwáyēs, p. 59, for a-tchimi-wáyäs *I extend to you* (tchánki *my hand*); púngin tchimwáyis *we two extend our hands to you.* 2) *I sell, convey.*

wákäs, wággäs, du. of subj. wak'hógis, pl. lúmhis *I am prostrate; I lie on the ground.* wákin, wággin (verbal) is a sort of expletive ("lying there") added to the terms for roads, paths, rivers, fields, etc. 8, 27. 29. 12, 32; cf. takwakídshäs.

Wáli, nom. pr. of an Apalatchúkla war-chief 8, 10; cf. the (Spanish) name of Guale, now Amelia Island, on the Atlantic coast of Florida.

wanáyäs *I tie;* cf. iwanákäs.

wánhi, pl. wánwahi *strong; hard, consistent, but compressible,* as leather, etc.

watúla *crane, heron;* watúla-háki, -hágī *crane-whooping;* also the name of a water-course in Alabama 14, 30. 31.

wē'tis, wäítis a modal, verbal form to be expressed by the adv. *probably, likely; may be, may possibly be.* The infinitive wétita is not in use. hi'lit wē'tis *may be best* 8, 24; hítchkuidshi wäítis *would likely bring forth* 12, 18. Cf. i'lki-túyäs, and wäítäyis in paradigm i. 206.

wi-kä'wa, o-i-kä'wa *spring* of *water* 8, 31; cf. o-íwa. Der. o-íwa, káyäs.

wilágīs, cf. á·läs, isá·läs.

wilako-ídshäs *I have two going around, about me;* hóman wiláko-idshit *having two going in front* 16, 18; cf. 19. Der. wilágīs.

wisáχa in tchánki wisáχa *my finger,* lit. "my hand's prong, my hand forking out, p. 60." Another term for it would be: tchánki wisákti hámgi *one of my fingers.*

wúlgis, úlgis, du. of óssäs, q.v.

wulhokχäíta; see óssäs.

Special Directions

for the Use of the Hitchiti Glossary.

The Hitchiti language, still understood by about six hundred people dwelling among the Creeks and Seminoles in the Indian Territory, is a vocalic and euphonic dialect of the Maskoki family, and almost in every respect comparable with Creek. Its phonology, accentuation, wealth of inflectional forms of the verb and its peculiar syntax compare closely with the parallel features of Creek. That Hitchiti was formed independently from Creek is sufficiently proved by comparing both with the other Maskoki dialects; the differences are mainly lexical, nasalized vowels are but little more frequent. and, although it borrowed some terms directly from Creek as the more frequently used dialect,* it approaches Cha'hta and Chicasa in many terms of daily use, like óki *water*, ókli *town*, pokóli *ten*, yákni *land*. Nevertheless it stands nearer Creek than Alibamu, Koassáti, Cha'hta, Chicasa, and Apalache, as well in grammar as in the lexicon. The cumulation of the prefixes and suffixes, the use of the verbal singular and dual with a subject standing in the plural, the lack or non-use of relative pronouns, with many other features, are common to Creek and Hitchiti. The excessive use made of the participles and all sorts of verbals, produced by the want of the relative pronoun and of suitable conjunctions, effects a cumbersome incapsulation and makes long sentences extremely heavy in both dialects. Instances of this appear on every page of our version of the legend, which is the first connected text of Hitchiti which has ever appeared in print. Verbals showing syntactic subordination to the main verb occur in large numbers, where we would apply a finite verb introduced by some pronoun or conjunction. Coördinate verbals like those in 24,

* For instance: tchátu konáwa *money*, tassikáya *warrior*, tamamápka *drum*.

33 have to be connected by ***and*** whenever they are rendered in English. The two versions give at least a correct idea of these dialects, although it is not claimed that the Indians of 1735 have used exactly the same terms which we give in our texts.

The more important directions for the use of the Hitchiti Glossary are contained on pp. 72. 73; I therefore subjoin only a few supplementary facts and rules.

For the proper names of persons, towns, tribes, and localities, see the Creek Glossary, and observe that Hitchiti substitutes the ending -a'li (-a'lut, -a'lun) to the Creek -algi in tribal names.

To find certain nouns and verbs, having *pronouns prefixed* to them in the Glossary, observe the same rules and restrictions as in the Creek.

All transitive and intransitive verbs were quoted in the first person singular of the declarative mode, in the present tense with the ending -lis (-alis, -ilis etc.), the impersonal verbs showing the terminal -is, -s.

The verbal paradigm of Hitchiti as given in vol. i. 83–85 is incomplete in some respects. The few additional forms given in the following list will therefore materially help the studious reader in the comprehension of the text, the full understanding of which, in spite of the explanations in the Glossary, is by no means an easy matter. In passing from the present to the preterit a change of quantity is observed in the radical vowel in Hitchiti as well as in Creek.

The suffix -tawāts (for -tawatis) is being appended to the verbal in -k inflected through all persons; it does not inflect for person, and through its component -ta- points to a past more or less remote. This syllable -ta- is also found to possess the same function in -ta'h-, -tahómit, -tahúnka and the Creek -tati. This tense runs as follows: 1 sg. isíliktawāts, 2 sg. isitskáktawāts, 3 sg. ísiktawāts; 1. pl. isígaktawāts, 2 pl. isátskaktawāts, 3 pl. iságiktawāts.

The suffix -wāts (for -watis) forms a tense, which corresponds to our preterit, but likewise to the present tense, and is often used to express verbs which in the English text stand in the conditional and subjunctive mode. The inflection is that of -tawāts without the -ta.

The suffix -tahómit figures as the mark of the *pluperfect* tense, and also appears under the form -hómit, -hómid. Sa'li-yahómid *after having gone with it* 22, 27 is derived from isa'lí-yalis, sa'líyalis *I proceed, advance with* something. This ending is also appended to a verbal in -k; thus from itumpihílilis *I mix, mingle with* this tense is formed as follows: itumpi-hílilik-tahómit *I had mixed* (it) *with;* itumpihiligak-tahómit *we had mixed* (it) *with.*

The infix or suffix -ta'h-, -taχ- is mentioned in the H. Glossary, and corresponds to -tati, -ta'hti of Creek, q.v.

The verbal suffix -tchamas is equivalent to the Creek suffix -ankis, -angis, which comes nearest to our perfect: isäyángis *I have taken.* Cf. 23, 18.

The verbal suffix -ugas, -ukas points to a conclusion drawn from circumstantial evidence; cf. 24, 31, úmmilis and ómäs in the Glossaries; it corresponds to the Creek -tchukis, -tchuks, -tsuks, and represents the verbified causal suffix -ga.

The suffix -kani is in fact an adjective used enclitically, and -kayus is its verbified form.

The ending -ga, -ka (-uga, -iga) is that of a verbal showing causality, and becomes verbified in -ugas, -ukas.

The suffixes -kan, -gan and -tahúnka are explained in separate items of the Glossary.

THE HITCHITI GLOSSARY.

abanálilis, pl. of obj. abanáslilis *I tie, fasten to;* pret. abanā'lilis. abánaslik *having tied, tying* or *fastening to* (a *long* in the syllable -nas-) 24, 6. Der. banálilis.

ábi, ápi 1) *stem, body of tree;* immápun (for púkabi immápun) *by the stem, trunk* or *body* of the *pole* (the orphan was killed) 21, 26. 2) *stick, pole.* Composes íkabi, púkabi, etc. 3) *handle* of ax or any other implement. 4) *likeness, image;* tä'g=(for täíki=) ábun *the image of a woman* 22, 25. Also in yátabi *portrait.*

Abíχka'li, sg. & pl., nom. pr. *Abika Indian;* in the English "Obikaw" 22, 21.

abitilíχtchut úmmilis *I originate from, I am a descendent of:* abitilíχtchi *descending from* 25, 12. The simple verbal form abítilis is not in use.

abotulídshilis *I cover;* abōdulídshik *having covered* 23, 22. Cf. unalobídshilis.

adsh-, atch-, prefix embodying the idea of being *behind, after, in the rear of.*

adshaka'líalis, du. adshaka'lisigas, pl. adshaka'ládshigas *I accompany, go with, go out following;* adshaka'líak *having followed, gone with* 25, 34. Der. a'líyalis.

adshakúntilis, du. adshakuláwigas, pl. adshakuntídshigas *I follow, come* or *walk behind;* yátipi adshakúntiti sunában ómmîg *so that the man-eater could not follow;* lit. "man-eater to follow-not possible making so" 23, 22. 23. Der. úntilis.

adshálaχkis, see álaχkilis.

adshóki, adshúngi *many, a number of;* nági=adshû'ngun *many things* 21, 15; adshok'=apiktcháχat *the largest number of, most of them* 20, 25. Instead of this may stand as well: adshókakat *the majority of them;* the terminal containing the inflected suffix -aka.

áfalis, pl. of obj. ásfalis *I take in my arm* or *arms;* obj. animate.

afóksalis, du. and pl. of subj. alítikas *I enter, go within, go inside of;* in the past tenses, partic. pret. etc.: *I am inside, I am within*, as in a road, field, boat, etc.; afóksak ú'mha-'hmis *it was inside of* 23, 19; alítak *to go in it, to march upon* (that path) 23, 10. 11.

áhi, áhe 1) *tree* when *standing;* áhi taláki *log;* cf. talángalis. 2) *water-potato*, the edible rhizoma of some species of the Sagittaria growing in fresh water. Called so from its elongated shape and forming the names of Ahíki creek (vol. i. 77. 125), of Chicasawhay river (Tchíkas'=áhi) and of the Cha'hta tribe which once lived on its banks: also the tribal name Ahí=pat ókla "potato-eating people" (i. 104. 109) by which the Chicasawhays are meant.

ahí'lus *it is better, preferable;* ahí'lowats *it were preferable, it would be better* 23, 26. Der. hí'li.

ah=opóski *boughs, twigs, rods*, lit. "little wood" 23, 22; in the singular áhi wiktchosíχtchi. Der. áhi, opóski (hopúski).

aitídshilis *I possess none, I have, own not;* aitídshiti *possessed of none;* (they) *having not any* 24, 4. Der. aítis; cf. í'litchilis.

aítis *there is none;* aitíktawats *there was none* 21, 26.

aitusíχtchi *deprived of, not having* 21, 27. Der. aítis.

áyalis, du. of subj. ya-ukígas, pl. ya-ulídshigas, i-aulídshigas *I am going about, am in motion, moving; I go along: I am about, I am there*, with the idea of motion implied: *I busy myself at.* Ayan *going, being in motion* 25, 7; áyak *being about* 23, 17; tchafísaχgak áyalis *I am alive*, lit. "I am about breathing, still breathing"; áyali, éyali, archaic for áyalis *I walk about* i. 79; ayawáti, archaic for áyawāts *it is walking* i. 79; túklak yá-ukan *two are going* 24, 37; yá bíχki yá-ukaχat *just these two who were ahead* 24, 38: the suffixed particle -aka, -aχat is here inflected. Yá-ulidshik ú'hmisis *have been there apparently* 24, 36; yā't yaúlidshik úmmis (what kind of) *people had been there* 23, 10; a'ládshik yá-ulidshiga *when proceeding on their way*, lit. "when being in motion journeying" 24, 37; itihi'lkíkuska ák'lik yá-ulidshiga *when they are on their way desirous of concluding peace* 22, 37; híni hátgi ummí'htchi ya-ulí'htchikat úmmiwats *they were the same as* *those who had been busy* (or *moving about*) *making the white path* 24, 15. 16; ya-ulitchúχan-tun *to move in* the white path 23, 11: ya-ulídsoχ sonábahos *should be prominent* through influence or authority, lit. "should be going about (as speakers, rulers, or commanders)" 22, 8; yátut ya-ulídshi=hi'lut úmmihin *they were certain that people had been there*, or *people had been there without doubt* 23, 7; ya-ulídshitigus *they would not stir*, *move about* in a healthy condition 22, 6. The above passages show that this verb is often used as a mere auxiliary *to be*, embodying the additional idea of *motion*. Cf. í'ligas, under tchukúlilis; also úmmilis.

ayámkalis, du. & pl. ayamkígas *I am with*, *I am together with;* 'láki ayámkûn *and arrows going with it* 22, 32; ayámkan isáyak; cf. isáyalis.

áyi *bed*, *couch;* imáyi í-aχnun *under their beds* 25, 19.

áyiktchi, á-iktchi 1) any of the smaller *plants* or *weeds: herb*, *weed*, *moss*, etc. 2) *plant* serving as a medicine; *medicinal drug*, *medicine* 21, 32. 22, 4; ayitchû'ska (subj. case with -ska) *sorts of medicinal herbs* 21, 14.

ayiktchúmi, aiktchúmi, pl. ayiktchúma'li *Indian conjurer*, *medical practitioner;* hilis'=háya in Creek.

ayógaχtchi *overlaid* to a certain depth; táli ayógaχtchut ómmîg *having rocks scattered about* 23, 13 (subj. há'htchi Kolósi). Der. áyi; cf. hayóχki.

ayokáhaχtchi, hayoka^{n}háχtchi *burning*, *blazing; on fire* 21, 13. 23, 29. Der. tchayokáhas.

ayosíχtchi *reaching just so high*, *just up to* 22, 21.

áyosin *reaching up to; up to.*

ak-, prefix analogous in function to ak-, the Creek prefix, q.v.

áka, -áχa, -aká, -aka, -ak, -ka, -χa, -ga, particle chiefly used in an *additive* sense, and suffixed to nouns, pronouns and verbs. It is frequently enclitic, and when suffixed to substantives or other nouns it can become inflected by case. 1) *Also*, *too*, *likewise:* hadshitúlam' aká *the eagle also* 22, 35; ifón=aχá *his bones also* 23, 30; kitíschăχăt.......... hátkakat *the red ones*.......... *also the white ones* 22, 38; apáluakat *and on the other side* 23, 31; istúklaχa *two together* 21, 36: tchíχnak *ye also* 25, 15; magá, máka *that one too* 21, 19. 20 (from ma, áka). 2) Referring to something *previously* mentioned; generally untranslatable in English, sometimes by *just*, *perhaps*, or some other adverb: úmmis=aχá *could perhaps be* 23, 9. 10; yá-ukaχat *just those who went* (aχa is inflected here) 24, 38; tchipi'hlitchíg=aχa the poles *that had been* previously *set up* 22, 13. In this function the particle also serves for the gradation of adjectives in forming a sort of superlative: apíktchi *chief*, *principal*; apíktchaχa *principal* among those previously mentioned, *most*, *more* than others. Cf. apíktchi in 23, 26 and other passages.

akásamilis 1) *I believe*; akásamiti (they) *believed it on that account* (-ti) 25, 35. 2) *I praise*, *value*, *esteem*.

ak'hóliχtchi 24, 31: see áklilis.

áklilis, áχlilis 1) *I think*, *suppose*; *I think so*, *I am of the opinion*. ā'klig for ákĕlik, áklik (supply ánut *I*) *I am thinking so*, vol. i. 79; ák'lut ómmiwats *they believe*, lit. "they are wont to think" 22, 36; áχliktawāts *they supposed*, *thought* 23, 11. 24, 16. 28; aχliti *as they were thinking*, *supposing* (verbal) 20, 26; ákliχtchut úmmiktawats *was considered to be* the most prominent 22, 19; ak'hóliχtchut ū'mmiwāts (passive) *it is commonly thought so*, *supposed* 24, 31. 2) *I want*, *desire*; *I propose*, *attempt*; *I strive*, *exert myself*; ákĕlik hitchígun *wanting to find out* 21, 3; atá·likun áklik *trying to find out* 24, 17; ak'lígalākas *we shall try*, *attempt* (to kill him), construed with the infinitive in -iki 23, 20. Cf. ísilālis, a *future* tense, vol. i. 83.

ákni, ákĕni 1) *flesh*, *meat*; íkni *its meat*, the flesh or meat of some animal. 2) *body* of person or animal; *person*. Adshákni *my body*, idshíkni *your body* 25, 16; tcha- *my*, tchi- *thy*, *your* being inverted into adsh-, idsh-; íkni *his*, *her*, *its body*, *their bodies*; ákĕni hátki *white man*.

áksi 1) *root* of plant, tree, bush 21, 34. 2) *string*, *cord*, whenever fastened to something else; *bowstring*; káway=áksi *rope*, lit. "horse-string." To áksi corresponds the Cha'hta term íksa, yéksa *its string*, which, like the Aztec mecatl, has also assumed the signification of descendency: *clan*, *gens*, *tribe*, *tribal division*. Cf. the English "family-tree, family-branch," etc.

áktchōmi *Indian tobacco; tobacco;* cf. vol. i. 58. Aktchomodshóhin (contracted into aktchomódshōn) *and* (-hin) *little tobacco*, -ódshi being the ending forming diminutives 21, 35. The seeds of this weed are distributed during the busk in the town square; cf. i. 179.

áχki *my mother*, said by adults; íki *his*, *her mother;* íki aitusíχtchi *motherless*, *orphan whose mother is dead* 21, 27; cf. ámwādshi, imilō'dshi.

aχliti *as they thought* 20, 26; cf. áklilis.

aláfangas in tchaláfangas *I blaze up*, e.g. when garments on the body take fire; alafáng'_εumigat *blazing up* 21, 8.

álaχki 1) *part*, *portion of*. 2) correl.: *the one* .., *the other part* 20, 24. 25, 22. Verbal of aláχkilis, q.v.

álaχkilis *I am left over;* aláχkiktawāts *remained*, *were left over* 25, 7; adshálaχkis *I am left over*, *remain;* ánut adshálaχkis *I am left alone*, *I became widowed* (male or female); anokólosik adshálaχkis *I remain alone*, or *I survive*, lit. "I only am left alone."

alabalídshilis, pl. of obj. alaba'hlídshilis *I lay*, *deposit close to* something.

Alibáma'li, sg. & pl.; nom. pr., *Alibamu Indian:* Alibáma'lohin *hereupon the Alibamu Indians*, in the English text: "Atilamas" 22, 20.

alitak, alítikas; cf. afóksalis.

alok-, aluk- *back*, *again;* prefix pointing to a return, a coming or bringing back, especially when prefixed to a verb expressing a rising, or a motion directed towards the one speaking; cf. -alun in yobalálun.

alok'hádshilis, du. alokloχókigas, pl. alokloχos-kádshigas *I have risen*, *I stand on my feet;* aluk'hadshá-aliwati, archaic for aluk'hadsháliwāts *it has risen*, *stands on its feet*, vol. i. 79. Der. hadshálilis.

alokistchanáplilis *I shoot back with*, *by means of;* alokistchanápliktawāts *they shot back* (red arrows) 25, 2. Der. istchanáplilis.

alokyalalídshilis, pl. of subj. alokyalaskádshigas, pl. of obj. alokyalaslídshilis *I return* something; alokyalalíndshiktawāts *they returned them* (by shooting) 24, 19; alokyálakakat *the returned ones* (partic.) 24, 20 (could also refer to *one* object returned).

alok'laníyalis, du. of subj. alok'laníshigas, pl. alok'lanisyádshikas *I come out again* after crossing; *I arrive on the other side*, as of a river; *I come out*, *rise from*, *emerge*, (persons, celestial bodies). Alok'laníshiaktawāts *they issued*, *came out of* 20, 21; as a tribe or body of people is here the subject, the dual is used here instead of the plural alok'lan yádshiktawāts, although the use of the latter would not be faulty; cf. Ceremonial Allocutions, p. 59 sqq.; alok'lanisyádshitikus *they had* or *would not come out*, *emerge* from the river, or from the hollow formed by its banks 24, 28; alok'laníyahin *then* a rat *came out of* 22, 29; cf. 'laníyalis.

alok'linígalis, du. alok'linísgigas, pl. alokmutágigas *I run towards*; alok'línigak *having run towards* 23, 24; alok'liníngas *he*, *it ran towards* the one speaking.

aloktigónknalis *I raise my body;* refers to the placing of the legs into a position for rising; vol. i. 79.

aloktchabáklilis *I raise my head;* aluktchabakliwáti, archaic for -wátis, -wāts *it has raised its head*, vol. i. 79.

aloktchukúlilis, du. alokwikígas, pl. aloktchukuslídshigas *I rise up*, as from the bed, couch. Der. tchukúlilis *I sit*.

alokúntilis, du. alokuláwikas, pl. alokuntídshigas *I approach*, *come up to;* inhu'lóska alokúntilā'ā (whenever) *their enemies will approach* 23, 1 (future tense); alokúntin *coming* 23, 3; alokúndi'ht ómiwāts *they are in the habit of approaching* (the male camping-place) for alokúndi'htchut ómiwats 22, 4. Der. úntilis.

alostá'htchi, alostá'ʼtchi *desirous*, *showing proclivity;* imalostá'htchi *inclined toward* 25, 13. Der. alósti.

alósti *desirous*, *anxious;* atasúntun imálostud *inclined toward the war-club*, viz. the shedding of blood 25, 18.

a'ládshigas and forms derived from this; cf. a'líyalis.

-a'li a suffix of tribal names, or designating classes of persons, etc., corresponding to -algi of Creek: Kasi'tá'li, Maskoká'li, hunaknosá'li.

a'líaka *from that time onward*, *since then* 22, 1. Der. a'líyalis, áka 2).

a'líyalis, du. of subj. a'líshiyas, pl. a'ládshigas *I walk, march, travel, journey;* when used impersonally, *it* (the time) *elapses, passes by.* hántun a'líyaktahōmid *he had gone somewhere;* a'líyaktawats *the time passed on* while they thought (ák'lik) they would not disturb it (nanumidshití-hin) 22, 28. Ho'lún a'ládshotis! *let us go, start for war!* 22, 12; hu'lúska a'ládshiwats *whenever they may follow up warfare* (-wats forms a potential mode) 22, 37; a'lá-dshíktawāts *they travelled, journeyed* 20, 28; a'ládshik *as they journeyed* 23, 5. 12; hántun a'ládshik yá-ulidshiga *whenever they are on a march,* lit. "whenever at journeying they busy themselves" 24, 37; hó'li a'ládshika *when they go to war* 21, 28—cf. 24, 31; a'ládshikan *while marching, journeying* 21, 2; a'ládshiga *on their way* 24, 11; a'lá-tchiga *where they had gone,* or *their trail* 24, 25; a'lá-tchika u'ládshiktawāts *on their way they arrived at* 24, 8. 24, 2; hó'lusga a'ládshāhik *for starting on the war-path* 23, 35; a'ladshíχtchut úmmiwats *they are in the habit of starting* 23, 37; a'ladshíχtchut úmmiktawāts *they habitually travel* 24, 38.

a'lípi postp. *up, upward,* in reference to rivers, valleys; há'htch=a'lípi *up stream.* Cf. áti.

ama'hmús *it is better, preferable;* ama'hmówats *it would be better* 20, 26.

ámbi *up, above;* ámbi 'látaχun *towards the sky, upward, skyward* 21, 8. *Sky* is hasóti in H.

ámwādshi *my mother,* said by children only; cf. áχki.

anáhilis, pl. of obj. anáslilis *I tell, relate, count;* anáhin *relating, recounting* 25, 35.

anódshki *dream.* Der. núdshilis.

anō'lilis *I eat up, devour, consume;* anō'lilis *I ate up;* yáχ-nut hoboskû'n imanólîhîn *the Earth ate up their children,* lit. "ate the children that were theirs (im-)" 20, 22; ima-nóliktahunga imúngahin *was in the habit of devouring from them formerly* 20, 27; imanolí'htchut ómmiktawāts *he was wont to devour* people, relatives *who belonged to them* (im-) 22, 25; yátun pum-anolíχtchut *eating up our people,* or *people away from us* (for pu-im-anóliχtchut) 23, 18.

anólispi *number;* imanólispi *its number* (being) 20, 4. 8.

apā'ksas *the day dawns, daylight appears.*

apaluá'htchi, apaluáχtchi, adj. 1) *being, dwelling on one side;* 2) when correl., *being on one side* .... *on the other side* 25, 23.

apáluak, apáluaka (from apálui áka) *on one side of;* correl. apáluak .... apaluákat *on one side* ...... *on the other side* 25, 29. 30; apáluakat ...... apáluwut (same) 23, 31.

apálui *on the other side of; opposite to.* Ilígi apálui *after death,* lit. "on the other side of death"; há'htch=apálui 1) *on the other, opposite river-side.* 2) *the other river* or *creek,* lit. "the river on the other side." Apáluan ..... apáluan, correl., *on one side* .... *on the other side* or *bank,* said of a river 25, 22; same as apálu-un or apáluwun; cf. i. 85.

apatalídshilis, du. of subj. apatalídshigas, pl. apataslídshigas *I go alongside, I follow,* as a river-course; apatalídshik *following* 24, 33.

apíktchaχat, abbr. piktcháχat *most.* This term is composed of apíktchi and the inflected particle áka; it forms a sort of superlative for certain adjectives: adshok' apiktcháχat *the largest number of* 20, 25; náχnos'=apíktchaχat *the most ancient* or *influential* among them 22, 14; lápk=apiktcháχat māmitíwats *it would not be well that the totality of them* (lit. "really all, mainly all") should die 23, 26.

apíktchi, apí'htchi, abbr. píktchi *principal, main, chief;* ímmig=apíktchi *their head-chief* 20, 12; yóbali píktchi *away behind, far behind.* Cf. bí'hki.

apóftilis *I think, suppose.*

apónilis, du. of subj. apúsnīgas, pl. apusnídshigas *I speak;* apónik, hapónik úngaktawāts *they were making speeches* 20, 19; aponiktahû'ngat û'mmis *spoke thus long ago;* the *thus, so* is embodied in û'mmis, lit. "thus was speaking long time ago" 20, 11.

apû'ngi *word, term; words, talk, speech* 20, 7. 25, 34.

ásalis *I assist, help;* ása'htchi *a helper, one who assists;* imásalis, immásalis *I assist, help somebody, do good to him, her, them:* nági imása'htchut *in something he has helped them* 25, 33.

ási, ássi (*a* short), a shrub called *Ilex cassine*, from which the Indians made the "black drink," an intoxicating, or, when much water was added, exhilarating beverage, served up at solemn occasions, and used as a medicinal drug by conjurers 25, 14.

asówalis *I pursue, chase;* asówak *while pursuing* 25, 7. 8; asówahin *then chased, pursued them* 23, 25.

áspi, áshpi *maize, Indian corn;* aspúshka *even maize* (they had not) 24, 4.

atabáksalis *I meet, find, fall in with;* atábaksik *falling in with, finding* 25, 8; atábaksiktawāts *they met with, found* 21, 12.

atá·lalis 1) *I learn, I acquire knowledge;* atá·laktawats *they learned* 21, 15. 16. 33; atá·lak *in order to learn, to find out* 23, 10; atá·ligun ákelik *trying, wanting to find out* 21, 6. 24. 17. 2) *to know*, like *novi* from *nosco:* atá'lowats *they know it* 25, 33; atá·laχ=hí'lut *knowing it quite well, for a certainty* 25, 32.

atá'li, pl. atá·lagi *one who diagnosticates diseases;* in Creek kí·la. Der. atá'lalis.

ata'lkatíχtchi 1) *unknown;* 2) *stranger.* Partic. of atá'lalis, with the privative particle -ti, q.v.; yáti ata'lkatíχtchut úmmigma *although he was an unknown person, a stranger* 25, 32. 33.

átasi *war-club* of wood, with a stone point inserted in its flexure 21, 29. 25, 16; atasúntun imálostud *inclined towards the war-club* 25, 18.

áti, postp., *down*, in reference to rivers, valleys; há'htch=áti *down the river.* Verbified in áhi=taláχut áta^{n}yas hátchun *the log drifts down the river.*

atchíban, atchíba, atchíbi *during, for a long time* 22, 27; atchíbahin *after a long time* 22, 29.

a-ulitkádshilis and it=a-ulitkádshilis 1) *I kindle a fire*, as a camp-fire 22, 2; 2) *I encamp, strike camp;* it=a-ulitkádshik *encamping* 20, 30. Der. íti *fire;* cf. aútilis.

aútilis and it=á-utilis, it=aútilis *I make fire; I build a camp fire.* ítautik *making a fire* or *fires;* aútis! or ítun aútis! *make a fire!* Der. íti, aútilis; cf. vol. i. 74.

awiládshilis, pl. of subj. awiládshigas *I approach, come near to*; awiládshitik *not approaching* (-ti *not*) 22, 3; ká-igi awiládshin, postp., *close to the pit*, lit. "approaching the pit" 23, 27.

awilosin *by, near, close to*; im-awilosi-hin *very close to it* 23, 8. Der. awílun *near*, -si.

awílun *near, near by, close to*.

bádshki, pl. badshbóki *long, elongated*.

bádskiχtchi, abbr. pádski'ht', pl. badskbókiχtchi *provided with* something *long, elongated*; hádshi bádskiχtchut "long as to its tail," *provided with a long tail* 22, 23.

banálilis, pl. of obj. banáslilis *I tie, fasten*; banā'lik *having tied*.

batáplilis, pl. of obj. batáspilis *I strike, hit*; conjugated vol. i. 84.

bí'hki, píχki, adj., *who is in front, ahead, in advance*; yá bíχki *those ahead* of the others 24, 38. Apheret. from abí'hki; radix ábi. Cf. apíktchi.

bí'hkun, píχkun, adv., *at first, firstly, ahead* 22, 13; bi'hkún í'mpi'lban *throwing in his way, before him* 23, 27; bí'hkun yá-ukan *two going in advance* 24, 37. Apheret. from abí'hkun.

éyali, same as áyali; cf. áyalis.

faskí'htchi *point*, as of arrow, knife; imfaskí'htchi ómik *making a point to* (the arrows) 24, 6. Der. fáski (Creek) *pointed*.

fáti Indian *cane-basket*, bottom with four corners and rounding up towards the top, holding about one bushel; fátut áhi i-aχnun wíngas *two baskets lie under the tree*.

fisakgígi 1) *breath, breathing*; 2) *life*.

fisáχkalis, pl. of subj. fisaχkígas 1) *I breathe*; 2) *I am alive, I live*; 3) *I rest, take a rest, refresh myself*; fisáχkak *taking a rest* (verbal) 20, 30.

fógi, fō'ki inflected temporal particle corresponding to the Creek -ófan, -úfan, -of. 1) *when, while, at such a time*: í'lik fógi *when assembled* 21, 37; mámik=fógi *at such a* *time*, *in this case* or *instance* 22, 2; mámiga fóχun *about then*, *at that epoch* 22, 7; cf. 23, 25. fógun *at that epoch*, *time* 20, 6. 10; hídshak fógot *when they saw*, *perceived* 21, 13. 2) *after*: ilídshik fógi *after killing him* 23, 34: ni'htági kolapágik fógun *whenever seven days had elapsed* 23, 33.

fósi *bird*; fos'= hátgi hísgi *feathers of a white bird* (better, fos'= hátg' ihíski); in the English, "white feathers" 25, 19. The description of the miraculous bird: 22, 23 to 23, 4.

g-. For terms with initial *g*-, see *k*-.

hadshalídshilis *I make stand*, *set up standing*, the object not being set in the ground; inhadshalídshiktawāts *they set up erect for him* 22, 26. Der. hadshálilis; cf. tchipilítchilis.

hadshálilis, du. loχókigas, pl. loχoskádshigas 1) *I stand*; i-aχnun loχókigas *we two stand below* (a tree, bluff, etc.) 2) also used in the sense of *I am*, *I exist*; hadshálik úmmis *he stands up*, *exists so* 25, 12; cf. huíläs (Creek).

hā'dshi *tail* 22, 23; ihádshi *its tail-feathers* 22, 36.

hadshitúlami *eagle* 22, 24. 35.

há'htchi 1) *stream*, *rivulet*, *creek*; 2) *river*. The two rivers meant in 20, 3 are in fact three; the Chatahuchi R. with the Lower Creeks settled on it; the Coosa and Tallapoosa rivers with the Upper Creek towns built on them. Cf. oki= tchóbi.

ha'htch=apaluá'li, adj. 1) *the one* or *those on the opposite river-side*; 2) Ha'htch=apaluá'li, nom. pr. given to the Upper Creek Indians; it really signifies "the people of the other river," meaning Alabama river with its two affluents, Coosa and Tallapoosa: 25, 25.

ha'htch=atá'li 1) *the one*, *those on lower river*; 2) Ha'htch= atá'li, nom. pr. given to the Lower Creek Indians on Chatahuchi R. in Alabama and Georgia: 25, 25.

háyak, pl. hahóyak *ripened*, *ripe*; nágut índshiwatki háyak û'mmiga *the first ripe fruits*, lit. "what first is likely to ripen" 21, 38.

háyatli 1) *light*, *splendor*; 2) *open country*, *prairie*.

háyatlin 1) *at dawn;* also hayatlí'htchi ílan, lit. "dawn coming on"; 2) *the next morning, the next day* 20, 31. Obj. case of háyatli.

hayokaháχtchi; cf. ayokaháχtchi.

hayóχki, pl. hayoχhógi *deep, deep down;* hayoχkún ómig *"deep-like," deep* 23, 21.

hayóχkis *it is deep,* vol. i. 81.

hákalilis, háklilis *I hear;* usually in the form: inhákalilis *I hear of it, I hear it;* cf. ἀκούω construed with the genitive; apúngi ínhak'lik *hearing his speech, words* 25, 34. 35; inhákĕlik *hearing it* 21, 2; inhaχlíktawats *they heard, became aware of* 21, 6; inhag'líχtchût û'mmiwats *they hear it usually* 24, 32.

hálbi 1) *skin;* frequently ihálbi *"its skin";* hálbûn *on a skin* 20, 7; yúktch=hálbi *shell of turtle.* 2) *bark;* ō'dshak'=hálbi *hickory bark;* ahi=hálbi *bark of tree.*

há'lana 20, 28; see hási 'lána.

hampádshilis *I spoil, deteriorate;* inhampadshiwátis *it would be spoiled to them,* to their disadvantage (conditional mode) 22. 5.

hámpaχtchi *battle, fight.*

hámpi, pl. hamhópi *bad, useless; wicked, mischievous; ugly, homely;* cf. tchahámpus, *I am bad;* hamhopó-sin *worthless, unavailable* 20, 33.

hánta=fō'χun, hanta=fógun 1) *so high as, in such a quantity* (*o* long) 22, 17; 2) *whenever, when* (*o* short). Der. hánti, fógi.

hantámiska; see mámi hantámiska.

hánti, pron. dem.-rel., 1) *whoever, whichsoever, which one;* hántut naχnosót úmmik *which* (tribe) *was the bravest* 22, 7; hantu=χánut *whichever first;* 2) *so much;* when used in an adverbial sense: *very, greatly, intensely* 20, 28.

hant'=úngaχtchi *noisy, making noise* 21, 25. Der. hánti, únkalis.

hántun, hantû'n 1) *wherever* 24, 37; 2) *somewhere,* vol. i. 79; 3) *from where, whence:* handû'n úngahōs *whence it was sounding* 21, 2; 4) *whenever* 24, 37. Der. hánti; cf. -hōs.

hántuntun *which way;* hantú'ntuska *everywhere, all around* 24, 32.

hapónik 20, 19; see apónilis.

hā'si 1) *sun,* also called ni'htag míki; hā'si alok'laníyis *the sun rises;* 2) *moon,* also called hās'=u'htáli; 3) *month:* hā's' 'lámi *one month.*

hā'si 'lána, hás='lána, hā'='lana, hás='lanaχtchi *sunrise; east.* há'lana 'látaχun *eastward* 20, 28. 23, 15; hás='lanaχtchún *from the east* 21, 17. Der. hā'si, 'laníyalis.

hátki, hátgi, pl. hat'hógi *white;* okátki *sea, ocean;* híni hatga=χántut *the white path in preference* (to others) 25, 31; híni hátgi *the white path* 24, 15 and often; ákĕni hátgi *white man.*

hatkólis, pl. hatkógas *I am white;* hátkoktawāts *was white* 23, 6; hatkáloχatis *ye let it be white* 25, 15; tchahátkas *I become white.* Der. hátki.

hatlídshilis *I whiten;* hatlídshik *having whitened* (it) 23, 2; hatlídshitis! *whiten* (it)! 25, 17.

hawáklilis *I open;* said of the mouth only. Háwaklis! *open your mouth!* hawákĕlin *opening its mouth* 20, 20.

hiat=ípi same as yát=ipi, q.v.

hidshahû'dshilis *I show, exhibit;* mígun hidshahû'dshikan *when exhibiting* (the arrows) *to the chief* 24, 19. Der. hídshalis.

hídshalis 1) *I see, perceive;* hídshaliktas *I have seen* many years ago; hídshaktawāts *they saw, perceived* 21, 4. 23, 7; hídshak fógot *when seeing* 21, 13; hi-itchak-táχtchut úmmik *as they had seen, perceived first* 25, 28 (ta'h-, taχ- as the *first* ones); hi-i, vocalic diæresis for emphasis. 2) *I find, discover;* hitchígun *to find out, to explore* 21, 3; hídshaktawats *they found* 24. 25. 26.

hídshkalis, hítchkalis *I appear, show myself;* hídshkak *as appeared, showed itself* 24, 25; hítchgatin *invisible, not to be seen* 22, 18 (ti- privative particle); inhítchkaktawāts, there *appeared to them* 21, 32.

hiläíχkalis *I cry;* wákäs in Creek.

hí'latis, in tchahí'latis *I am not good, useful,* etc.; inhí'latik *not being acceptable, being disliked by them,* lit. "for them good not being" 20, 23; hí·latik ú'mmis *it is not good*, *it is a bad sign* 24, 20: tchúnus'≈hi·lalátik *restless*, lit. "troubled in its heart" 21, 24 (-la- *very*, -ti *not*); tchúnus'≈hí'lawats *for quieting* (it), lit. "that it may be quiet at heart" 21, 26.

hi'látchilis *I improve; I render peaceful, quiet;* lit. "I make good." tchúnus'≈hi'látchilis *I quiet down* somebody's mind.

hí'li, pl. hís·li (plural unusual); 1) *good*, *excellent* in a physical, concrete sense: *beautiful*, *fine*, etc. 2) *good* in the abstract and moral sense: *useful*, *cheerful*, *well-minded;* hí'luska ómikūs *may be*, *would probably be preferable*, *better* 23, 11. 3) Appended to verbs or adjectives it corresponds to our *for good*, or *sure*, *certain; surely*, *certainly*, and is inflected with the main word: witíχka'h≈hí·lut *very angered*, lit. "angry for good" 23, 24. Quoted under each main term.

hi'lkíki *peace* 25, 14; cf. híni hátki, under híni; hi'lkígut óm-miwats *the white* (feathers) *mean peace*, *are peace* 23, 1. Der. hí'li.

-hin, enclitic particle, generally of a temporal signification: *then*, *hereupon*, *next in order*, *and*, *still*, *subsequently;* sometimes it is untranslatable in English. The o-, u- before -hin in nouns is the o-, u- of the subjective case: pasóhin *namely the* pā'ssa 21, 34, for pasút≈hin; hó'lohin for hó'lut≈hin, etc. The term huyanídshōn is a contraction of huyanítchut≈hin, huyanídsho≈hin. It also occurs in Alibáma'lohin *then the Alibamu Indians* 22, 20; onálihin *then disclosing* 21, 33; imúngahin *still continuing* 20, 27 mámihin, mámin *and* 21, 4. 5; inkúslihin 22, 33; imanólihin 20, 22; í'lihin 23, 16; imísohin 25, 3; impatíhin 23, 36; imumpí'lpahin 23, 24; asówahin 23, 25: gitistchóhin 23, 31; oklóhin 25, 9; una'lálihin 23, 28. See also 24, 25 etc.

híni *path*, *road*, *way;* h. hátki *white path*, viz. path of peace, peaceful behavior to neighboring tribes.

híski 1) *hair;* 2) *bristle;* 3) bird's *feather;* fós' ihíski *birds' feathers* 23, 2; fos'≈hátg ihisk'≈aχá *also a white bird's feather* 25, 19: *also* referring to the verb of the sentence: gave.

hĭ'tu'lpi; cf. tú'lpi.

hítchkä-is, in anhítchkä-is, or anhítchkash *I obtain*, *get*, *acquire;* lit. "it appears to me"; inhitská'htchi *which they* *had obtained for themselves, for their use* 22, 5; inhítska-hí'lut *they have luck;* lit. "they get for themselves with certainty" 23, 38; inhitchäkaktahúnga a'líaka *since they have got for themselves, discovered* 22, 1.

hitchlídshalis *I engender, bring forth;* lit. "I make appear"; hitchlídshiska í'liwāts *it might bring forth* 22, 28. Der. hídshalis; -ska (particle).

hitchlídshilis *I obtain, acquire;* inhitslídshatskaktahúnkma *they could have obtained it for them* (their children) *before this* 24, 21; -tskak- is the suffix of the 2d per. plural, -ma (q.v.) *although* makes a conditional form of this complex word, and tahû'nk- places the act into a remote past.

hodshífalis, hutchífalis *I name, I give name to;* hodshífaktawats *they named it so* 21, 9. 24, 12; mû'n hudshífak úngaktawats *they called it thus;* lit. "that naming (the river) they called it" 23, 14.

hodshífki, hútchifki *name, appellation.*

holátli, hólätli, pl. holat'hóli *blue;* íti holätlút *a blue fire* 21, 18.

hó'li, hú'li (*o, u* short) 1) *war, warfare* 21, 28 etc.; hó'li mí'ki *war-chief,* commander in war 20, 13 etc.; ínho'li míki *their war-chief* 20, 15; ího'li kapitáni (same) 20, 18. 2) *enemy* in war: ínhu'li yōs'-hálbun *with the scalps of enemies* 22, 13; inhu'lóska *even their enemies* 23, 1.

hó'lilis, hú'lilis 1) *I boil,* v. trans.; hó'lokan *when boiled;* 2) *I am warring.*

honi'lí, huni'lí *north;* honi'lú'n *from the north* 21, 21.

hopánalis, hupánalis *I sing, chant;* hopának *having sung,* or *by singing* 21, 32; hopā'naska *it sings sometimes* 21, 23.

hopánga *song, chant.*

hópilis *I bury, inter;* hópik *burying* 25, 19.

hopóyalis *I hunt, chase, pursue, seek,* as game, etc.; hopóyigas *we are hunting;* hopóyaliχtchamat *what I have been hunting;* hopoyigaχtchámat úmmiwats *they were really those sought, looked after by ourselves* 25, 10.

hopû'ski, opóski *children,* pl. of awaktsû'dshi and of yátudshi *child;* hoboskún *the children* 20, 22. The plural of wíktchi, q.v.

-hōs, -hus, verbified suffix marking surprise, wonderment; handû'n úngahōs *whence the noise sounded from* 21, 2. 3. cf. úngalis; sonábahos 22, 8. cf. sónaba; imillidsholiós 22, 31. cf. ilídshilis; úmmikus *probably*, q.v. for û'mmika hōs.

hóti'htchi 24, 34; pl. of tchóba'htchi, q.v.

-'htchi, -χtchi 1) suffix forming past participles; kádshilis *I say, call:* kádshiχtchi *said, so called, named.* 2) suffix of adjectives: bádski *long:* bádskiχtchi *having, provided with* something *long;* cf. aítis and aitusíχtchi.

huyanī'dshi, the word huyanídsha, q.v., borrowed from Creek and provided with the Hitchiti ending *-i* 21, 34.

hunákni, pl. of nákni, náχni, q.v.

húndshilis, hóntsilis *I leave, quit, abandon;* hóndshig *departing from, leaving* 23, 5; húndshik 24, 1; hún'htchik *having left, departed from* 24, 8; húndshitik û'mmiska *nevertheless they do not abandon*, viz. "they adhere, stick, cleave to" 25, 29.

-húnga, -hunka, -ûnga, suffix forming verbals which refer to a time elapsed long ago. In our text it occurs, e.g. in i'láhúnka *where they once lived, their former residence* 23, 5; yáli i'lihúnga (same) 24, 8; i'lídshihungat *which they then were possessing* 23, 29. Cf. -tahúnga.

hú^{n}χkalis, pl. of subj. hú^{n}χkigas *I whoop.*

hû'nli 1) *sacred;* 2) *costly, expensive, high-priced.* Cf. ni'htakhúnlan and the Cha'hta nahúllo, nahúnlo; Note to vol. i. 105.

hupánaχtchi *the singing* (in present or past) 21, 5. Der. hopánalis.

hutä'gi, pl. of tä'gi, q.v.

í-aχni, yáχni, yákni 1) *ground, soil* 23, 21; 2) *earth, land, territory;* Tchā'tchā'li íyaχni *the land, country, state of the Georgians* 20, 8; 3) *the Earth* personified 20, 20–22. 27.

í-aχnun, yáknun, postp. *under, below, beneath.* Der. í-aχni.

i-aukígas, i-aulídshigas; cf. áyalis.

ibasnā'dshik 21, 3; see tchabánas.

ibasnā'dshitik 20, 27; see tchabánas.

ídshi *mouth*, lit. "his, her, its, their mouth"; yák'ni idshún *from the Earth's mouth* 20, 21; idshû'n hatlídshik *his mouth whitened*, viz. full of spittle 23, 2.

idshíkni 25, 16; see ákni.

ífi *dog;* if=míki *dog-chief,* a war-title 20, 14; ífut áχnun anólis *the dog eats up the meat.*

ifóni *bone,* lit. "his, its bone"; ifon=aχá *his bones also* 23, 30.

íftchi *gun;* iftchi=kutû'kbi *bow,* lit. "crooked gun" 22, 32.

i'hkíkut 23, 16; i'hkígut 24, 29; see íngalis *I say.*

íkabi 1) *end, top of;* áh'=íkabi *tree-top.* 2) *headwaters, source* 21, 1. Cf. íka *his head* (Creek), ábi.

íki, cf. áχki.

ík'ni, íkni; see ákni.

il-, ili-, prefix of the reflective voice in Hitchiti verbs; cf. ilbatā'plilis in vol. i. 85. In ili- the second *i*- is the pronoun of the 3d person.

ílalis, du. of subj. itaúkikas, pl. iládshigas *I come, arrive;* ílălis *I have arrived;* ílak (*i* long) *coming* 22, 24; *having come, having arrived* 22, 26; yát=ipi ílak *the man-eater coming* 23, 33; imílakma *although it came to them* 21, 17; fósi ilá'htchi *the coming bird* 22, 26; ílaktawats *came, arrived* 21, 18. 20. In the sentence previous to this the verbifying -tawāts is not appended to ílak. Cf. háyatlin.

ilī'dshilis, pl. of obj. ilístchilis, more frequently oksídshilis (*I annihilate*) *I kill, put to death, massacre.* ilídshilis *I killed, I have killed* (second *i short*); ilídshiktawāts *they killed* him 23, 30. 25, 8; ilídshiki (we will try) *to kill him* 23, 20; ilídshik fógi *after they had killed him* 23, 34; ilíχtchi'hlati'htchut úmmiwāts *they will never kill habitually* (la- future tense, ti- negat. part.) 23, 4; imillidshohós ák'lik *trying to kill* its father *away from* (the rat) 22, 31; ilihû'dshiktawāts *was killed* 21, 27. 22, 34. Plural: yátun ilístchik *killing* or *having killed people* 22, 25; ilístchiχtchud úmmiktawāts *he was in the habit of killing* 23, 33; lápkun oχsídshihin *then they killed all* 25, 6.

ilimásalis *I help myself, I defend myself;* ilimásis! *help yourself!* pl. ilimásatis; nánōmik ilimásatäi (verbal) sonábas *I am made defenseless,* lit. "it is not possible to defend myself in any way whatever" (ti- *not* is included in -täi); nánōmik ilimásatäi sonában *being made defenseless* 22, 33. 34.

ilumpihálilis 1) *I throw down on;* illumpihálik *having thrown on, upon,* 22, 13; 2) *I pour on myself.* Der. ili-, un-, pihálilis.

i'lígas, i'líkas *we sit, reside, live;* pl. of tchukúlilis, q.v.

i'lin *next, coming;* in ní'htagi i'lin *next day* 20, 20. The literal meaning is "there was a day," or "at a certain day." Der. i'lígas, under tchukúlilis.

i'lítchilis 1) *I possess, have, own:* i'lídshik *having on himself* 23, 2; i'lídshik ú'mmes *they have it,* lit. "possessing they are so," 21, 23; i·lí'tchiχtchût ómmiktawāts *was the owner, proprietor of* 22, 32; i'lídshihungat *which they had with them, owned, possessed* 23, 29. 2) *I keep, preserve:* i'lídshi imúngawats *they are continually preserving* 23, 30. 31.

í'liwats, 22, 28; see tchukúlilis.

í·lki *father,* lit. "his, her, their father"; tchá·lki *my father.*

i·lkólis *I am the father of;* i·lkówats *was its father, might be its father* 22, 30; i·lkuktahúnga *being his father,* or *the father of such a one.*

imígak 25, 20; see íngalis *I give.*

imilódshi, in ik=imilódshi *motherless orphan;* lit. "motherless-little," "mother of the little one from it deceased" 23, 27. The diminutive ending -ōdshi stands here for the subst. yátudshi *child.* Der. im-, ínlilis, -ōdshi.

imípibak 20, 32; see ímpalis.

imísikan 25, 5; see ísilis. imísohin 25, 3; see ísilis.

ímpalis, more frequently impípalis (medial form), *I am eating;* ípalis, ipípalis *I am eating it;* ímpak *eating, feeding on* 24, 5; impatíhin *then they fast, do not eat* 23, 36. imímpalis, pret. imípalis *I eat of it;* 'lá·lusk imímpibak *eating of the fish also* (oki=tchóbi [fish] *of the river*); ·lá·lusk imípibak *having eaten of the fish* (im- refers to *river*) *also* 20, 32.

í'mpi, ípi *eater, consumer;* occurs in yát=împi, q.v.

ímpigi "something to eat"; impigúska *victuals, food* 24, 21; lit. "food of some kind." Der. ímpalis, -ska.

imúngalis, abbr. múngalis *I continue to be* or *to do so; I keep on doing.* Imúngawats *they continued, kept on* 23, 31; imúngawats *it continues* (to thunder) 21, 11; imúngahin (or múngahin) *still continuing* 20, 27; imúngak (or múngak), verbal used adverbially: *continually* 25, 9. 13.

íngahin 20, 6. 23. 19; see íngalis *I say.*

ingalis, ínkalis, pl. íngigās 1) *I say, tell; I say so.* hántut î'ngan *which one to say, to direct* 22, 8; íngahin (like û'ngahin) *and he said* (the following words) 20, 6; *they also said* 23, 19. î'ngaska *that could say, even to say* 21, 26; íngak û'ngalis *so I said;* íngalin, ingígan *I, we saying;* íngaktawāts *he said* 24, 20; *they said, reported* 23, 18. náki ingaktahúnkat û'mmis *what he has formerly said* 20, 4. 2) *I call, name, call by name:* i'hkígut *so called, named* 24, 29; i'hkíkut 23, 16.

ingalis, sg. & pl. of obj. *I give;* unusual form for imíngalis, *I give to.* imígak *having given to them* 25, 20; ífun immíkis! *give it to the dog!* Der. íngi (Creek) "his hand."

inhitska-hí'lut; cf. hítchkä-is.

ínlilis, du. púnlis, pl. oksígas, u*z*sígas *I die, expire;* ífut ilípas (medial voice) *the dog expired;* 'lámosik inlikántun ahí'lowats *it were better that one should die* 23, 26; imínlalis (not imínlilis), pl. imóksigas *I die for* somebody, something. The plural oksígas really means *we become nothing;* in Cha'hta and Koassáti íksho: *nothing.* Cf. ilídshilis.

inóti *tooth*, lit. "his, its tooth"; pusáfi inótuska tchunu'lúska *either beaver's teeth or flint* 24, 6.

intchiwátki (índshuatki in i. 82), 1) *the first*, lit. "the one beginning" 21, 33; 2) *at first, firstly* 21, 4.

í-obali, í-obalun; see yóbali, yóbalun.

ipági *six;* ipágiska *or six* 22, 3.

is-, isi,- isim-, isin-, issi-, si-, sim-, sin-, prefix forming 1) instrumental verbs and their derivatives; sometimes is- indicates the indirect object of the verb. The second i-, im- etc. of isi-, isim- etc., represents the pronoun of the 3d pers. 2) isi-, ísim- etc., compound prefix of verbs and adjectives, often indicates gradation; among the numerals, the ordinals have the prefix is-, or s-. Der. ísilis; cf. -si (suffix).

isabóklilis *I wrap up, envelop* something; imaboklígas *we are surrounding.*

isáyalis, du. isya-ukígas, isi-aukígas, pl. isya-ulídshigas, isiaulídshigas 1) *I carry about me, I have with me;* ayámkan isáyak *having been about his person* 20, 19; isiaúlidshik û'mmiga *when they take along with themselves* 23, 37; isiaúlidshis (such as) *they carry with them* 21, 30; isiaúlidshiktawāts *they took it with them* 21, 13; isiaulí dshiχtchut ómmiwats *they carry it about habitually* 22, 38; isiaulídshi'ht úmmiwāts (same) 21, 29; íti ishiaulídshihûngat *the fire which they previously possessed, had with them* 21, 22. 2) *I am about, continue doing; I busy myself at:* the medial form of áyalis, q.v. isiaulídshiktawāts *they were about* speaking to the rat 22, 31; isiaúlidshika *if they* (the women) *were moving about* 22, 5; itikádshik isiaúlidshik *continued to discuss about*, lit. "having continually spoken to each other" 22, 8.

isayatáplilis *I strike against* an object; isayatáblik *throwing, hitting, striking against* 21, 27. Der. yatáplilis *I strike;* cf. batáplilis.

isa'ládshigas 25, 7; see sa'líyalis.

isa·léχki, isa'lä'-iχgi *remembrance; substitute of, token* 23, 35; hi'lkíki isa'lä'χkun *as a sign of peace* 25, 14.

isa'líyalis, du. and pl.; usually shortened into sa'líyalis, q.v.

isatá·lki, satá·lki *sign, proof, mark.*

isatá·lkus *it is a sign, token, mark, proof of;* isatá'lkalaχa (and -laχas) *it will be the proof, sign of* 25, 16.

isbatä'plilis, pl. of obj. isbatáspilis *I strike, hit by means of, with;* isbatáspilis *I strike repeatedly with;* tchû'yi isbatásbig *beating, striking repeatedly with* (burning) *pine-wood* 23, 30. Der. isi-, batáplilis.

ishialágak 22, 27; see is-yalángalis.

is'hídshilis 1) *I see, perceive by means of;* 2) *I discover by means of, with.* Der. hídshilis.

is'húndshilis *I depart from, leave;* is'húndshidshitik *still persisting*, lit. "not departing from," 25, 18.

isi-, isin-; see is-, isi-.

isiámika *together,* "consisting, composed of these," 20, 16. Der. is-, yámika.

isiaúlidshiktawāts 21, 13; see isáyalis.

isihótosi, pl. of isitchobáχtchi, q.v.

isilafista-ílilis, apheret. silafista-ílilis *I apply, administer to myself;* isilafistaíli'htchut (abbr. isilafistaíli'ht) ómiwats *they were applying it to themselves* (by drinking, rubbing on, etc.). In text: "medicine to purify themselves," 21, 37.

ísilis, pl. of obj. áwalis *I take, seize; I hold, carry*. í'sik *taking* 21, 28; *having taken* it 22, 26. isiχsihómīd *having taken; obtained*, plpf., 21, 13. imísik *taking* their property, *taking it from them* 25, 19; imísikan *after capturing for themselves* 25, 5; imísohin *then took for themselves, for their benefit* (im-, -isut, -hin) 25, 3; in the English text: "they determined to take the town."

isinhí'la'htchi *preferable to, better than* 25, 31. Der. hí'li.

isínpatki *faster, swifter than* 22, 24; cf. pátki.

isitágika *the fourth* 21, 35. Der. sítagi.

isitchobáχtchi, pl. isihótosi, comparative of tchobáχtchi: 1) *larger, greater than;* 2) *chief, principal;* ókli isihótosi *the principal towns* 25, 26. Der. isi-, tchóbi.

is-yalángalis, isialánkalis, du. isialáskigas, pl. isialaskádshigas *I return with* something; ishialágak *having returned with it;* in English translation, "brought it back" 22, 27. Der. yalánkalis.

iskaláfki *knife;* iskaláfkoga *as for a knife* or *knives* 24, 7.

iskitistchátchilis *I redden by means of, with;* iskititchádshotis *let us redden, let us paint it red with* clay 22, 10—having the indirect object in the objective case. Der. kitístchi.

iskolapákika *the seventh;* iskolapákikan *on the seventh* (day) 23, 36.

issitágigat 21, 35; see isitágika.

istúklaka *two together, two joined* (aka, particle) 21, 36.

istutchínaχa *the third* 21, 34. Der. tutchíni.

istchanáplilis *I shoot with, by means of* (a bow, etc.); istchanápligan *having shot with* 25, 2; istchanápliktawāts *they shot with* 24, 17; istchanáplika (the arrows) *which they had used for shooting*, or *in order to shoot back with them* 24, 18.

isú'lalis, isó'lalis, du. isús'ligas, pl. isus'ládshigas *I reach, arrive upon, by means of* (a road, trail, etc.); isus'ládshikan oklóhin *and when they had reached on* the trail *a town* 25, 9. Der. isi-, ó'lalis.

itamo'látchis; see lámo'li and tamo'látchis.

it=a-ulitkádshilis; cf. a-ulitkádshilis.

itaútilis; cf. aútilis.

itsá-utilis; cf. aútilis.

íti, í'ti 1) *wood, firewood, fuel;* 2) *fire* 21, 7; íti hátgut *a white fire* 21, 17; cf. aútilis.

iti-, it-, itim-, itin-, prefix pointing to reciprocity: *each other, mutually*, and forming the reciprocal voice in Hitchiti inflection. The forms iti-, itim-, etc., are compound prefixes, the second component being the pronoun of the 3d person. Der. íta (of Creek).

itíbilis *I fight;* itíbik *having fought; after a fight, battle* 25, 3.

itihí'lkalis *I conclude peace with;* itihi'lkíkuska *when making peace* 22, 37. Der. hí'lkiki.

itikádshilis 1) *I say to, tell another; I dispute, discuss.* itikádshik *discussing over* 22, 8. 2) *I agree with, consent;* itikádshiktawāts *they agreed* 22, 9. 11. 15. The intricate syntax of the sentence from 22, 7 to 11, having only one finite verb at the end, must be resolved as follows: Mámiga fóχun itikádshik isiaúlidshik (*to discuss continuing*): hántut ya-ulídsoχ sonábahos: 1) naχnosót úmmik, 2) "nákoska yá'hmitis" í'ngan;—itikádshik (*agreeing*) ógli sitágiti: "mámut úmmitis; pokábi sitákin tchipi'hli'htchik lokfún iskitistchádshotis (laknû't û'mmikma nohádshokan gitistchá'htchut û'mmiti)" itikádshiktawāts. By omitting itikádshik in 22, 9 the sentence would become much more lucid and comprehensible.

itimapónilis, du. itimapúsnīgas, pl. itimapusnídshigas 1) *I talk, confer with;* itimapusnídshik *conferring, speaking with* 22, 30; 2) *I deliberate with.* Der. apónilis.

itumpihílilis 1) v. trans. *I mix, mingle with;* itumpihä'ʻhlilis *I mixed it with;* itumpiliktahómid (for itumpihiliktahómit), plpf., *which they had mingled* 21, 22. 2) v. intr. *I associate, unite, live with;* itúmpiχkak (for itumpihilí'hkak) *having lived in common* 25, 21.

itunábas, in amitunábas *I am prepared, ready;* imitunábaga *while, when* (-ga, suffix) *they are getting ready* 23, 36; cf. sonába.

itunáyalis, du. itunya-ukígas, pl. itunya-ulídshigas *I go to and fro, forth and back;* itunáyăkan *when coming and going* 22, 26. Der. iti-, un-, áyalis.

itunt ulópkalis *I jump, skip over* something; ituntulupídshis *they jump over it.* Der. iti-, un-, tulópkalis.

yá, i-a, hía *this, this here,* anim. and inan. 21, 1; yá náki yámika *these things* 22, 1. etc.; yayúska *this person, this thing;* yá í-obalun *after this, thereupon* 23, 5; yá for yámika *those* men 24, 38; cf. yáli, yámika, ma.

yá'hmis *it is so;* nákoska yá'hmitis! *let the thing be so!* 22, 7. Der. yá, úmmilis; cf. mámilis, mátis.

yalánkalis, du. yaláskigas, pl. yalaskádshigas *I turn back, return* in another direction than towards the one speaking; yalaskádshik *having returned, gone back to* 20, 24; yalaskā'dshig *retracing their steps* 23, 9.

yáli, pl. yámika 1) pron. *this thing,* the word being accompanied by a gesture. 2) adv. *here;* yáli i'lihúnga *here where they had resided* 24, 8; cf. yá, yámika.

yálun, adv. *here, at this spot* 21, 12.

yámika, pl. of yáli 1) pron. *these things;* í-a náki yámika istúklaẓa *both of these things here* 21, 36. 22, 1; inserted twice through pleonasm. 2) adv. *now* 25, 31; cf. yamikáyi.

yamikáyi, yamiká-i, adv. *now, at present* 24, 2; cf. yáli, yámika, and áyalis.

yámiska *even now, even to this day* 21, 10. 30; cf. mámi hantámiska.

yámōsin 1) *so much of it, just so much;* 2) *subsequent, following* 20, 7.

yán *there, at that place* 21, 32. 23, 16. Der. yá.

yánasi *buffalo;* yánas=hálbi *buffalo-skin* 20, 7.

yáti, i-áti, í-at, hiáti *person* of either sex; *somebody.* yátun *a man, a person.* yáti, pl., *people, men* 20, 1. 21, 12. 25, 5. yátut 23, 7.

yatígi, i-atígi *interpreter* 20, 6.

yát=împi, yát=ipi, hiátipi *lion,* lit. "person-eater" 23, 17. 22, 33. Der. yáti, ímpalis.

yátudshi, pl. hopúskodshi *child* 21, 27; dim. of yáti, q.v.

ya-ukígas, du. of áyalis, q.v.

ya-ulídshigas, i-aulídshikas, pl. of áyalis, q.v.; cf. also isáyalis.

yehúndshilis *I leave at home, behind;* yehóndshiktawats *left it* where it had been brought to 22, 27. The prefixed ye-, yi- stands for the pron. i- (im-, in-) as a reflective pronoun.

yi'lílilis, i'lílilis *I burn, destroy by fire;* yi'lílo*χ*an *after burning, when* (it) *has been burnt.*

yobalálun, yupalálun *still behind, far back* 20, 25. Der. yóbali.

yóbali, yúpali 1) *behind, in the rear; next in order* 22, 20. yúpali=píktchi *away behind, far behind, hindmost.* 2) *afterwards, subsequently* 23, 9; *since then.*

yóbalun *afterwards;* yá í-obalun *after this* 23, 5.

yósi, i-ósi, i-úsi *head,* and *his head, somebody's head, their heads:* yō's=hálbi *scalp,* lit. "skin of head," 22, 13; yáti i-ósi *the heads of the people* 25, 5; tchayósi *my head,* tchí-osi *thy head,* puyósi *our heads.*

ka-, prefix referring to *water;* or "*down into.*" Cf. ak- (of Creek).

kabí'lbalis, kapí'lbalis *I throw into the water;* okitchóbi kábi'lbak *throwing into the river* 25, 5. Der. ka-, pí'lbalis.

kádshilis, pl. of obj. kahódshilis 1) *I say to, I tell somebody;* kátchiktawāts *he said* 24, 22; *they said to* them 23, 20: kahódshilis *I tell many people.* 2) *I call, name, give name;* kádshik ú'mmigma *although they call them* 25, 23: kádshik hodshífaktawāts *calling it so they gave name to it* (pleonasm) 21, 10; oki=tchóbi Nófāpi kádshigun *a river called Beech-tree* (river) 24, 2; Kolósi kádshiga, gádshikun *so called, having name Kolosi* 23, 12. 13; kahudshí*χ*tchut úmmis *it is called* now 24, 3; kahódshi*χ*tchut ú'mmigma *although they are called* 25, 24; gádshi*χ*tchut hudshífakta-wāts *thus calling they named him* 22, 35; tchakahódshis *I am called so.*

ka-élilis *I dig, excavate;* ka-élik ómig *having dug* 23, 21., lit. "dug having done so"; inká-ilik *digging for them-selves* 24, 5.

kahodshí*χ*tchi, partic. pret. pass. of kádshilis, q.v. Der. kádshilis.

kahódshilis; see kádshilis.

ká-igi, kä'-igi *hole, pit, excavation;* yák'ni=ká-igi *ground-pit* 23, 27.

kayá, kayap'hú, in vol. i. 79; see sutá.

-káyus, -χáyus, particle of gradation forming superlatives: nak-nosaχáyus *the oldest of all* 22, 19; lit. "it is the oldest one." Cf. apiktchaχáyus, vol. i. 81. Verbified from -kani, q.v.

kalífkalis *I gnaw, erode;* kalífkak *having gnawed through* 22, 33.

ká'lali and ka'láliχtchi *west;* ká'lali 'ladáχun *towards the west* 20, 20. 23; ka'lalíχtchùn úntiχtchut *coming from the west* 21, 19. Der. ka'lálilis.

ka'lálilis *I fall into; I fall into the water.*

-kan, -χan, obj. case of the verbal -ki, sometimes equivalent to our *when, while,* sometimes to *after:* hó'lokan *when boiled;* nohádshokan *when baked, cooked* 22, 10; yi'lílo-χan *after burning;* hidshahúdshikan *when exhibiting* 24, 19; imísikan *after conquering* 25, 5; itunáyăkan *when going forth and back* 22, 26.

-kani, -χáni, suffixed particle pointing to preference, priority; Kasiχta'loχánut *the Kasiχta people first* 22, 16; hantuχánut *whichever first,* for hántuntun=χánut; hatgaχántut *the white* in preference to others; Kasiχtá'lu=kánut *the K. people being the first* to see 25, 27.

Kasíχta, nom. pr. of *Kasí'hta,* a Lower Creek town and tribe of high renown and very ancient; called *Cussetaw* by Americans.

Kasíχta'li, nom. pr., *Kasí'hta* or "*Cussetaw*" *Indian* 25, 13. 20, 12; Kasiχtá'lu=kánut *the Cussitaws at first* 25, 27.

kitistchádshilis *I redden, make red, paint red;* gitistchá-'htchut úmmiti *as it* (the fire) *makes it* (the yellow clay) *red* 22, 11; kitistchádshik *after painting* them *red* 24, 18. Der. kitístchi.

kitístchi, gitístchi, pl. kitiskótchi *red* 20, 31; û'tski gitístch=aka *the red smoke* 25, 27; íti kitistchak=áka *the red fire also* (-ka *also,* -aka *and*) 25, 27; gitistchúti *as they* (the arrows) *are red* 24, 22; íti gitistchukmá laknû't *a fire, although red, yellow*—which means, "a fire which was yellow, though it was red also," 21, 21. kitístchăχăt ....

hátkakat *the red ones* .... *also the white ones* (eagle's feathers) 22, 38.

kolapági, kolapáki *seven;* kolapágiska *or seven* 22, 4; kolapágik fógun *when it was the seventh* 23, 33; tchók'hi kulapákin *seven hundred* 20, 5. 9.

Kolósi, nom. pr. of a stream, unknown which 23, 12.

Kósa'li, nom. pr., *Kusa Indian* 23, 17. 24, 1.

Kósi, Kō'si, Kúsi, nom. pr. of *Kusa*, one of the oldest towns and tribes of the Upper Creeks 23, 15.

kúslilis *I cut, sever;* inkúslihin *then cutting it for them* 22, 33.

kutāníyalis, du. kutānishyígas, pl. kutānisyádshigas *I go down into*; kutānisyádshik ómmik áχliktawāts *they thought* (the people) *had gone down into the hollow of the river-course, into the river* 24, 27; oki=tchóbun kutānisyátcho=hin (they found) *that they had gone down into the river* 24, 26.

kutúkbi *crooked, bent* 22, 32; cf. íftchi.

labákun, lapángun *close by, near to.*

labángosûn, adv., *near, close by, in proximity* 20, 21. Der. labákun, -si (suffix).

lak'háχtchi, abbr. lak'hátchi 1) *summer;* 2) *year* 20, 4. 8. 32.

lákni, pl. laχlóni *yellow* 21, 21; láknût ú'mmikma *although it is yellow* 22, 10. laχlóni is distributive: *yellow in spots.*

lámo'li *other, different; some else,* anim. and inan.; lámû'lun *at some other place, somewhere else* 22, 2; cf. tamo'látchis, tchalamó'las.

lápki, lábgi *all;* lā'pkût ágĕlîg *all exerted themselves* 22, 16; lā'pgun ímmigun *the king of all* mountains 21, 9; ókli lápkut *of all the tribes* 22, 19; ní'htak lápkun *every day* 22, 24; lápk'=apiktcháχat 23, 26; see apíktchi.

lókfi *earthy matter, dirt, clay* 22, 10.

lō'tchi, lō'dshi, pl. luslō'tchi *black* 21, 20.

lubulídshilis *I make sink into, I drown in, I cover by* objects *thrown over;* lubulídshin ummigá-i *whichever will cover* (the pole) *over* 22, 14; lobolidshíktawats *covered, made sink into, submerged* it 22, 17. 20.

'ladáχun, 'latáχun *towards, in the direction of* 21, 1; ká'lali 'latákun *towards the west* 20, 20. 23.

'láki, 'lági (*a* short) *arrow;* in'lagi *its arrows*, viz. the arrows belonging to the bow 24. 6; 'láki ayámkûn *together with arrows* 22, 32.

'lá'lu *fish;* 'lá'luska *even fish; fish of any kind* 20, 32. 24, 5.

'lámi *one;* in counting. 'lámin 20, 5. 9.

'lámosik *only one;* yáti 'lámosik *only one person* (obj. case), verbified in 'lámositis *let* him *be one only* 25, 20; ókli 'lámosiχtchut úmmiwats *they are but one, a single tribe* 25, 24. 25. Der. 'lámut, -si.

'lánaχtchi *place of rising;* hás='lanaχtchún *sunrise, east* 21, 17. For this might stand as well hás='lanáχtchi or ='lanaχtchúntun (viz. û'ndiχtchut). Der. 'laníyalis *I rise.*

'láni *mountain, elevation:* 'láni=tcheíhi *high mountain* 21. 4. 5. 9. Der. 'laníyalis *I rise from, emerge* (from the ground).

'laníyalis, du. of subj. 'lanishígas, pl. 'lanisyádshigas 1) *I cross*, referring to water only; 'lanisyádshik, many *having crossed* a stream 23, 15. 24, 14; 'lanóχ (apocop. for 'lanúχtchi) sunában ú'mig *having made it possible to cross, having made it passable* 25, 5. 2) *I rise from, come out of, emerge.*

'liníkalis, du. of subj. palákikas, pl. mutánkikas *I run, hurry;* palákakan asówak *the two who ran while pursuing* 25, 8; 'liníngalis *I ran* (preter.) Cf. alok'linígalis, un'linígalis.

'lúk *again* 25, 9; cf. the prefix alok-.

ma, subj. mût, obj. mún, sg. & pl.; pron. dem. *that, that one;* anim. & inan.; máka, magá (from ma) áka *that also, that one too* 21, 19, 20; ma umíχtchut *like it, looking like that* 21, 30; mû't ummiláχas *that one will be* (the oldest) 22, 14; mûn i'lídshik úmmes *that one* (fire) *they have* 21, 22; mun, mûn *these* (ripe fruits) 21, 38.

-ma, suffixed conjunction: *but, however, though, although;* its suffixation may turn a verb from the declarative into the conditional mode. Occurs in mámikma *but*, úmmikma *although*, -tahúnkma 24, 22; imílakma *although it came to them* 21, 17. Cf. also 21, 21.

máhamig, máhamik, abbr. from mahá-i'hmik, q.v.

máhamin, abbr. from ma há-i'hmin *then, thereupon* 21, 26; lit. "after doing that."

ma ha-i'hmi'htchi *after this had occurred; after this, since then.* ma haihimí'htchi i-óbali *since then* 23, 9; cf. 24, 11 (hai'hmí'htchi is the better orthography); cf. mamítchilis.

ma há-i'hmik, mahai'hmik, abbr. máhamig *then, thereupon, and* 20, 21. 29. 22, 12; same as má-umof (in Creek). Cf. mamítchilis.

ma ha-i'hmiktahúnga, abbr. ma'hmáhunga *after that, since then* 24, 1. 25, 20; cf. mamítchilis.

ma'hmahúnga, abbr. from ma hai'hmiktahúnga, q.v.

ma'hmihúnga, contr. from ma hai'hmiktahúnga, q.v.

maláli *the same, the identical one;* ahí malálut (of) *the same wood* 21, 31; malálun *in the same spot, place* 23, 34.

ma'lális, in tchama'lális or tchama'lálus, du. pumasá'lligas, pl. puma'laslídshigas *I am afraid, terrified, frightened;* imma'laslídshigut (many) *being afraid of it* 21, 11.

má'lä-iχki, má'läχki *of different quality, origin; different, various* 21, 12. 32.

mámgak *in that style* or *mode; in this strain*—said in reference to speeches or sayings. Contracted from mámin íngak "having said so."

mamgû'ngas *he, she said so;* contr. from mámgak úngas and used for quoting words and speeches of others 20, 6.

mámi, subj. mámut, obj. mámun, pron., *such, such one;*— mámi hantámiska *nevertheless,* in *spite of* 24, 23. 25, 26. mámiχ hantámiska (same) 25, 17; ní'htagi mámi î'ntchangin *on an appointed day,* lit. "when such a day comes upon them," 21, 37; mámut û'mmitis *let it be such, so* 22, 9; yáti mámi=ga tchabátis *such a person I do not want.*

mámigan, mámikan, abbr. mámik *then, and then,* lit "after doing so," or "when being so"; *and then* 21, 7; mámikan *and* 24, 25; *and also* 24, 25; mámik fógi, or mamikfógi *in such a case, at such a time, at that time* 22, 2. 23; mámiga fóχun *about that time* 22, 7. Der. mámilis.

mamí häi'htchik; see mamítchilis.

mámihin, contr. mā'min (Creek, mómin), mámen 1) *hence, therefore, thus;* mámin û'mmi mámiska *nevertheless* 20, 26; mámihin *on that account* 22. 6. 2) *and hence*, *and* 21, 4. 5. 22, 12; *and then* 22, 20; mā'min máka *and this one also* 21, 23.

mamikántun; cf. mámilis.

mámikma *but*, *however* 24, 18.

mámilis 1) *I do so*, *I act in such a manner;* mamikántun (for mámigan-tun) ama'hmówats *it would be better to act in this manner* 20, 26. 2) *I am so;* mátis, from mámitis *it is not so; no*, *not*. Cf. mámigan, mamítis, etc.

mámin, contr. from mámihin, q.v.

mámiska 1) *but*, *however* 20. 22. 25. 33. 22, 21. 25, 31. 2) *although*.

mámiti *therefore*, *hence* 22, 18. 23, 7. 34. 24, 16. Der. mámilis or mámi, and the *causal* -ti.

mámitis. contr. mátis *it is not so;* or as conj. *not*, *no;* mámitīga *if not so*, lit. "if it is not so, as it is not so" 22, 4. mamitíwats *it would not be right*, *just; it will not do;* lit. "it would not be that way" 23, 26. immamitíhin *it did not suit them*, lit. "it was not right to them" 21, 1. Der. mámilis, -ti.

mamī'tchilis *I do so*, *I act in this manner;* mamí'htchilis *I acted thus;* mamí'htchīgi *to do so* 22, 16; mamí'häi'htchik *having acted so*, *after doing this* 21, 28. 23, 23.

mámōsin *just so much*. Cf. yámōsin; suffix -si.

Maskóka'li, Maskoká'li 1) adj. *referring to the Maskoki* or *Creek people;* yáti Maskoká'li *the Creek people* 20, 1. 2) *Maskoki man*, *person* or *people;* Maskoká'li ímmigî *the chief of the Creeks* 20, 3.

mátis; see mámitis.

ma umíχtchi, ma ŭ'mmiχtchi, adj. *alike the one which; just like* 21, 30.

míki, mī'gi *chief;* Tchikílli Maskoká'li ī'mmigi *Tchikilli*, *the Creek head-chief;* lit. "Tchikílli of the Maskoki their chief" 20, 3. mígi tchóbi *the great king*, viz. the king of Great Britain 25, 34.

mituládshilis, apher. for immituládshilis *I throw down in* somebody's interest, *for* somebody; mituládshis *he threw it down for him;* cf. mitiweíkäs (in Creek).

múlgas, v. impers. *it is boiling;* ókut múlgas *the water boils;* cf. Okmúlgi in vol. i. 140.

mûn, mun *there*, *at that place* or *spot* 20, 30. 32. 24, 9. 10. 29; mûn í'lin *while they remained there* 24, 3; cf. 24, 30.

mû'ngak, múngalis, múngan, múngawats; cf. imúngalis.

mû'ska *just that one*: involves the idea of "better than another" (anim. & inan.); múska híni *just that path* 23, 10. Der. ma (in the form mut), -ska.

mût, mûn, pron.; see ma.

nakanáhigi 1) *mode* or *style of relation*. 2) *history*, *tale*, *relation of former events*; innakanáhigut *their history*, *traditions* 20, 2. Der. náki, anáhilis: "something to tell."

náki, nági, abbr. nak-, na- (in compounds). 1) *what*, *which*; chiefly applies to inan. objects. Náχot úmmiga *what it was*: lit. "what it was like" 21, 6; náki ingaktahúnkat û'mmis *what he said*, lit. "what he has been speaking" 20, 3. 4; náχuska *something* (living) 22, 27. 2) *thing*, *object*; nákoska, nákuska *something*, *that thing*, *anything* 22, 7. (o-, u- suffix for -ot, -ut, subj. case): nági=adshû'ngûn atá'laktawats *they gained knowledge in many things*, probably referring to medicinal plants and practices 21, 15.

nak=lápki, naχ=lápki *everything* 23, 6. Der. náki, lápki.

nákni, náχni, pl. hunákni *man*, *male person*; hunakní awiládshitik *not approaching the males* 22, 3; hunaknosa'loktahúnka, see náknosi.

náknosi, náχnosi, pl. hunáknosi 1) *old*, said of males; hunaknosa'loktahúnka *of the old people of yore* 20, 1; the term hunaknosá'li forms here a sort of *nomen gentilicium* to hunáknosi. Cf. -tahúnka. 2) *old*, *ancient* in the sense of "bravest," and therefore "first in war, leader on the battle-field and in the councils, prominent, influential"; just as the Romans derived *virtus* from *vir* man (nákni). Naχnosaχáyus *the oldest of all* 22, 19; hántut naχnosót úmmik *which* tribe *should be the oldest* 22, 7; náχnos=apíktchaχat 22, 14; see apíktchaχat. Der. nákni, suffix -si.

nákosi, nákusi *little object*, *small thing*; nākosúska *any little thing*, *even small things*; refers here chiefly to eatable bulbs 24, 5. The -u- in -sus- represents the case nákosut, or nákusun. Der. náki, -si.

nánōmi, nánumi; also nánumiga, nánomik *whichever*, *what-*

ever, what kind or *sort of;* nanómut ómmika *what kind* (of people) *they were* 24, 23; hí'ni, yát nánomût *what kind, sort of a path, people* 23, 9. 10; nánōmik ilimásatäi sonában *unable to help themselves in any way* 22, 34; ókli nánumigat bí'hkun *whichever tribe* would *be the first to* 22. 12. Der. ná- (for náki), in-, úmmilis.

nanumídshilis *I make use of, I put to use, I do* something *with;* nanumídshitiktawāts *they did not use it* 21, 17. 19. 20; nanumí'htchuk sonábaka *how they could* (possibly) *be put to use* 21, 14; nanumidshókat *how to do, manage it* 22, 31; nanumidshókan *what to do with it* (for quieting it) 21, 25; nanumidshitíhin *not disturbing it,* lit. "not doing anything with it" 22, 28. Der. na- (for náki), in-, ummídshilis; cf. sonába and the Creek omítchäs.

ní'htagi *day;* ní'htak lápkun *every day* 22, 24; n. í'lin *at a certain time or day,* lit. "there was a day" 20, 20; ní'htag' míki *sun.*

ni'htak-únlan, in anniχtak'hû'nlan *I have a sacred day;* inniχtakúnlan *they have days sacred to themselves;* refers to the annual busk 21, 36. Der. ní'htagi, hû'nli; cf. ukû'lintchi.

ní'lagi *night;* ní'lagi 'lámin *during one night* 20, 30. 24. 10.

nohádshilis *I cook, bake;* nohádshokan *when cooked, baked* 22, 11.

nū'dshilis, du. nūstchígas, pl. nustchídshigas *I sleep;* nū'dshilis, nō'dshilis *I slept;* nō'dshik (one) *sleeping;* nustchí'dshiktawāts *they slept* 20, 30. 23, 8. 24, 10.

ódshagi *hickory* 23, 21.

Ógil'lop, nom. pr. of Governor *J. Oglethorpe,* 25, 34.

ohí'laχtchi *populous, numerous, being in large numbers* 24, 9.

okā'si, ok-ási *spring of water* 20, 33.

ókbi *hole, aperture, orifice;* táli ókbun *in the opening of a rock; in a cavern* 23, 18.

óki, úki *water;* ok-ilósi *lake, pond,* viz. "lost water;" vol. i. 81.

oki-tchóbi, û'ki-tchōbi, abbr. kitchóbi *river,* lit. "large water," 20, 29; also used to designate brooks, smaller water-courses and large water-sheets, as Lake Okitchobee in Southern Florida. Cf. vol. i. 60. 81.

ókli, ógli, ókĕli, úk'li 1) *home, den, retreat;* amókli *my home,* amoklayóki, contr. of amókli hayóki *my town,* lit. "inside of my town." 2) *settlement, village, town, city:* Sevä'na ókli *at Savannah city* 20, 4; oklóhin (or oklō'n) hídshak *seeing that it was a town* 25, 9; óklun *a town* 23, 15. 3) *tribe,* or *population of a village, town* 22, 9. 12. Cf. ukólis.

okófki (pl. unused) *muddy* 20, 29.

oχsídshihin *then they killed* 25, 6; cf. ilídshilis.

o·l-, ō·l-, u·l-, prefix implying distance traveled over; an abbreviation of ó·lak, the verbal of ó·lalis, q.v.

o'ládshilis, pl. us·ládshidshigas *I make it reach, I cause it to reach* or *come up to;* o'ládshiktawats *made it come up to* 22, 21.

ó·lalis, ú·lalis, du. of subj. os'lígas, pl. os·ládshigas, the two latter being often pronounced o'lígas, o'ládshigas, and the sg. being really os·lális, ús'lalis. 1) *I reach to, come to, arrive at;* said of animate subjects. ó'lalis (*o* short), pret. *I arrived.* o'ládshiktawāts (for os'ládshiktawāts) *they reached* (a path) 23, 6. 24, 9. os'látchiktawats *they came to* 24, 13. u'ládshiktawāts *arrived at* 23, 12. 16. 24, 2. os·ládshik, us'látchik, u·ládshik *arriving there* 20. 24. 29. 32. The difficult sentence 24, 14–16 has to be construed as follows: "Having crossed (the river) on the next day, on their march (a'ládshigat) reaching a high mountain, they thought (ákliktawāts) that the people (yátut) staying (i·lin) where they (the Kasi'htas) had reached (u'látchik), was the same (úmmiwats, *was so*) which had been busying itself (ya-ulí'htchikat) in making (úmmi'htchi) the white path." O·ládshigan *having reached* a mountain 24, 15. os'látchigan *having reached, arrived at* 24, 34. 2) v. impers. *it elapses, expires, is completed, arrives to completion;* said of *sections of time,* days, years, etc. yán í·lin l. s. ó'laktawats *they stayed there four years;* lit. "there they staying four years were attained, completed," 23, 16. 17. í·lin n. k. ó'laktawats *they stayed there seven days;* lit. "in their stay seven days were reached" 23, 35. ó·laktawats *expired, elapsed* 24, 4. ó'lan *after* such a time, lit. "when reaching"

24, 1. ní'htagi ípāki ó'lan *during six days*, lit. "reaching six days" 23, 36. ó'lahin *after the completion of*, lit. "reaching to that (time)." 22, 4. Cf. the suffix -hin.

o'lanáhilis, pl. of obj. o'lanáslilis *I go and tell, report*. Der. ánahilis.

o'láni *cane, reed;* o'lánun tukaílik ú'mmiktawāts *they were in the habit of splitting canes* 24, 7.

o'lhídshalis *I see, find, discover after a walk or journey;* o'l'hídshak *having gone to see* 25, 34.

o'lílalis, du. o'lislígas, pl. o'liládshigas *I return, I arrive home;* o'lílak *after reaching home* 25, 35.

ómig, ómiga; cf. the more frequent ú'mmig, úmmika.

ómihin, ómiχtchi; cf. the more frequent úmmihin, u'mmiχtchi.

ómilis and its conjugational forms; cf. the more frequent úmmilis.

onálihin; cf. unálilis.

opóski, pl. of wíktchi, wiktchosíχtchi.

os'ládshigas, os'ládshiktawats; see ó'lalis.

os'laníyalis, du. & pl. os'lanis-yádshikas *I arrive on the other side;* os'lanisyádshikan hidshatíti *as they did not see* (the trail) *coming out* (of the river) *on the opposite bank* 24, 27. Der. 'laníyalis.

padshákfi, pl. padshakpáfi *flat; flattened* by pressure 25, 6.

pafáχsis, v. impers. *it smokes;* ítut pafáχsis *the fire is smoking;* ítut pafáχsin *a smoking fire* 25, 10; pafáksiχtchi (partic.) *smoking* 23, 13.

páhi *grass;* pahóska *even the grass, the grass too* 23, 6.

pákĕnûn, postp. *upon, on the summit, surface;* ipákĕnun *on its summit* 21, 5.

palákakan; cf. 'lilínkalis.

Palaχtchuklá'li nom. pr. (adj. and subst.) *Apalatchukla Indian;* his tribe and town formerly was on Chatahutchi river, Georgia 25, 11. 18.

pási *button-snake root;* cf. pā'ssa in Creek Glossary. In pasóhin 21, 34 the suffix -hin points to the order of enumeration of the four herbs, *namely*.

pátki, pl. patpáki *fast, swift;* said of a bird 22, 24.

pihálilis *I spill, pour out, throw out* as water, sand, seeds, and similar objects; pidshíktchi piháligun (desirous) *of spilling blood* 25, 13.

píktchi; see apíktchi.

pí'lbalis *I throw away, spill;* pí'lbalis *I threw away* (*i* short); í'mpi'lban *having thrown* it *to him* 23, 27.

pitchíktchi, pidshíktchi *blood;* pitchiktch=ómika, or p.=u'-mi'χtchi *blood-like, resembling blood* 20, 31; pitchiktchúska *just bloody* 25, 28; átasi pidshiktch=ukúli=ka *the blood-stained war-clubs* 25, 16.

pokábi, puχábi, pógabi *tall pole, pole;* ímpogabi *their pole* 22, 17. Der. púki, púgi *ball,* ábi.

pokóli *ten;* pokóli tutchínan *thirty* 20, 5. 9.

pón'li. pún'li, pl. pun'láli *wizard, witch.*

pu-, po-, poss. pron. 1st pers. pl. *our, ours;* púdshunusbi *our hearts,* cf. tchúnusbi: pu'mmigi (or púmigi) *our chief* or *chiefs* 25, 20.

pú'hni *we;* pu'hnáli *ourselves;* pumanolíχtchut, for pu-imanó-liχtchut, *devouring from us,* viz. "devouring our own people" 23, 18.

pusáfi *beaver* 24, 6.

puslídshilis *I cause* somebody *to fast.*

Safáni, Sĕvä'na, nom. pr. loc., *Savannah,* Georgia; Sĕvä'na ókli *Savannah town* or *city* 20, 4.

sa'líyalis or isa'líyalis, du. sa'líshigas, pl. sa'ládshigas 1) *I proceed, advance with,* or *while doing* something; sa'lí-yalik imúngan *I am proceeding with it continually;* sa-'ládshik múngak *still proceeding with* while pursuing 25, 8; asówak isa'ládshikan *while advancing in their pursuit* 25, 7; sa'liyáhōmid *having gone with it,* plpf. 22, 27. 2) *I continue doing* something.

sanátski 1) *the last;* 2) *at last, finally* 21, 20.

sánlik, sálik; cf. találilis.

satalídshilis, pl. of obj. sataslídshilis *I drag.*

satúklaka, (i)satóklaka *the second* 21, 34.

sá-uki *rattle* 23, 23.

sawátski, term borrowed from Creek; cf. Creek Glossary. sawatskō'n for sawatskóhin *namely sowátchko* 21, 35.

sáwi, sháwi *racoon*; cf. vol. i. 85. 96. 97. 144.

-si suffix: *only*, *but*; inflected: -sik, -sin, -sun; 'lámosik *only one* 23, 25: túklosik *but two*, *just two* 25. 6. 2) *just only* in the sense of *very*, *entirely*: labángosun *very near*, *just near* 20, 21; im-awílosi-hin *very close to it* 23, 8. Der. ísilis; cf. is- (prefix).

síliti 1) *slimy* 20, 29; 2) *slime*, *phlegm*; silī'tus *it is slimy*: no form for the plural.

sítagi, sítakî *four* 21, 32; itikádshik ógli sitágiti thus were *they agreeing*, *as they were four tribes* 22. 9.

situnába *divided up*, *apportioned to each*—verbified in: situnā'bigas *it becomes divided up to each of us*; pret. sitună'bigas *each of us has obtained a share*; fut. situnabikaláχas *a portion will go to each one*; tchikû'n situnabikaláχas ákliktawāts *they intended to apportion a house to each man* (or person) 25, 4. (-la suffix of one of the future tenses.) Der. isi-, iti-, únapa.

-ska, -shka, suffixed particle of various significations and often untranslatable in English: 1) when connected with substantives, pronouns, and adjectives, it is appended to the subjective case in -ut, which is shortened to -u, -o, and means *even*, *just*; ashpúshka *even maize* 24, 4; hută'guska *even the women* 22, 2; inhu'lóska *even their enemies* 23, 1; hu'lúska *just in war-time*; pahóska *even the grass* 23, 6; nákoska *something*, lit. "just a thing"; mû'ska *just the one*. 2) or it means *such as*, *something like*; 'lá'luska *fish of some kind*, *such food as fish* 20, 32. 24, 5; impigúska *food of some kind* 24, 21; ayiktchúska *some sorts of medicinal herbs* 21, 14. 3) correlative particle: *that one* .. *the other one*; inótuska tchunu'lúska *either teeth or flint-stones* 24, 6; *or* .... *or*: ni'htagi tsaχkípaska, ipágiska *five or six days*, etc. 22, 3. 4) connected with adjectives, -ska forms a sort of comparative: hí'li *good*, hí'luska *better*, *preferable* 23, 11. 5) by -ska adverbs and conjunctions are formed from pronouns: yámiska *just now*; mámiska *but*, *although*. 6) connected with verbs: íngaska *who could tell* 21, 26; hopánaska *it sings at times*, *sometimes* 21, 23.

sókodshi *door*.

solópi 1) *soul*; 2) *ghost*.

sonába, inflected sunábak, sunában, expresses the idea of possibility: sunában úmmilis *I render it possible;* ·lanóχ sunában u'mig *making it possible to cross* 25, 5; adshakúntiti sunában ómmig *made it impossible* (for the man-eater) *to follow* (them) 23, 23; itílbi sonábaχtchut ummi'htchámas *he has been a good fighter;* nánumiti'h (for nanumitiχtchut) sunábak *unable to act differently;* nánumiti'h shunában úmmilis *I disable him, make him unable to act in some way or other;* ya-ulídsoχ sonábahos 22, 8; see áyalis. Der. is-, únapa (*above*, in Creek). Cf. itunábas.

sowákalis, suwákalis, du. sowaskágas, pl. sowaskádshigas *I remove, migrate;* sowaskádshik *having migrated* 20, 23; cf. asówalis.

sutá. The refrain of the hunting-song, vol. i. 79. So, worded in the archaic style of language: sutá kayá, kayap'hú! *upward rise! start up!* is not pure Hitchiti, but approaches Creek. Sutá is connected with Cr. sutá. Hitch. hasóti *sky;* kayá refers to a *rise* (from the ground), cf. Cr. wi꞊ká-i *spring of water*, and is repeated in the last term of the refrain.

tafamángalis, du. tafamásgigas, pl. tafamaskádshigas *I cross, step across, step over*, as over a fence, log, hill, etc.; híni tafámaskadshig (they) *having stepped across the path* 23, 8.

-ta'h-, -taχ-, particle occurring as infix and corresponding to the Creek -tati, -tá'hti: *previously, first, at first; in early times;* hi-itchaktáχtchut úmmis *as they had perceived, seen first* 25, 28; ummiktá'htchuti *since they formerly were* 25, 28.

-tahúnga, -tahúnka, inflected nominal and verbal suffix referring to a past time, which in many cases is further removed from the present time than when -húnga, q.v., is used. It occurs frequently in our text, as in aponiktahúngat, ingaktahúngat, hunaknosa'loktahúnka, inhitslídshatskaktahúnkma, imanóliktahunga, etc.

taká·lilis, pl. of obj. taχás'lilis *I send out, dispatch*; cf. untaká·lilis.

talā'lilis, pl. of obj. talā'slilis and sánlilis, sálilis *I lay down, deposit, stretch out*, the object being of long shape and in-animate. Tală'lilis *I laid down* (one obj.), tală'slilis (more than one object); átasi találik *having abandoned, laying down the* blood-stained *war-club* 25, 16.

talángalis, du. of subj. salgígas, pl. salgádshikas *I lie down, am prostrate; I am stretched out.* talánkawati, archaic for talánkawatis (-wāts) *it is lying on the ground*, vol. i. 79; áhi taláki *log*, lit. "tree prostrate." Forms of this verb are used as classifiers or idiomatic expletives after words for river, lake, way, path, valley, etc.: híni hátkut talákan *the white path extending* before them 23, 5; talakákan *the one stretched out*, from talákan and -aka, -ka 25, 9; oki= tchóbi talákan *a river stretched out* 20, 29. That the four nouns preceding, which stand in the absolute case, have to be construed to stand in the objective case is shown by talákan; cf. talá'/an 20, 32.

táli (*a* short) *stone, rock;* táli ayóga'/tchut ómmîg *rocks being scattered there* 23, 13; tálun *rocks, large stones* 25, 4.

talílui *dance*, subst. Der. tálualis.

tálualis *I dance;* the radical tal- is often nasalized: tá^{n}lualis; yátut talhú^{n}was *people are dancing.*

tá'lalis, pl. of subj. tas'lígas *I weave, plait;* tá'lak *having woven, plaited, intertwined;* expresses the term "crosswise" of the English translation 23, 22. tá'la'htchi *woven* by them 23, 29.

tamámapki *drum* 24, 30.

tamo'látchis, in tsatamo'látchis *I undergo change, become altered; I am transformed.* Said of the change from health to disease: itamo'látchîwats mámik fógi *whenever they become sick*, referring to menstruation 22, 2. Cf. lamó'li.

tánki, pl. tántagi, tántaki *empty, vacant, deserted;* tchíki tánkōhin *and* their *lodges deserted* 24, 25.

tastĕnáki, pl. tastĕnaká'li *warrior* 20, 18.

tati, in ántati *my father*, said by children; cf. tsá'lki *my father*, said by adults; cf. -tati in Creek.

tä'gi, täígi, pl. hutä'gi *woman* 22, 25; hutä'guska *even the women* 22, 2; hutä'gāk *the women also* 22, 6.

-ti, -ti- 1) negat. particle *not*, usually suffixed or infixed to verbs, and differing from the privative particle -kō, -ku, -gō, which is usually connected with adjectives. We find -ti in adshakúnti-ti, hitchga-ti-n, iliχtchi'hla-ti'htchut, nanumidshi-ti-ktawāts, etc. 2) causal particle, chiefly suffixed to verbs: *as*, *since*, *because;* ógli sitági-ti *as there are four towns* 22, 9; aχli-ti *as they thought* 20, 26; akásami-ti *believed it on that account* 25, 35: û'mmi-ti *as*, *because* 24, 10.

tukaílilis, pl. of obj. tukáslilis *I split;* o'lánun tukaílik *splitting canes* 24, 7; the canes are here considered as a collectivity, hence the verb stands in the singular form. Contains íti *wood.*

túkla *two;* when counting, túklan. Túk'la *two* (years) 24, 4; túklak bi'hkun yá-ukan *two marching in advance* of the others 24, 37; lak'hátchi túklan *for two years* 20, 33; túklosik *only two* (-si suffix, *only*) 25, 6.

tukládshilis *I form*, *make up two; I have a couple;* tukládshiga *composing*, *making up the two* (rivers) 20, 3. Der. túkla.

tulópkalis *I jump*, *skip;* cf. i. 146.

tú'lpi 1) *knee*, *knee-joint;* hitú'lpi *somebody's knee* 22, 21. 2) *joint* of a cane; ítu'lpi, hítu'lpi *its joint.*

-tun, suffix appended to nouns and verbs, and having a potential and optative function. Not easily translatable in English. We find it before derivatives of hí'li *good* in yaulitchúχantun 23, 11, inlikántun 23, 26; besides these, in atasúntun, hántûntun, hantû'ntuska 24, 32., mamikántun, etc.

tunuχgáχtchi *thunder* 21, 2.

tunúχkalis *I am thundering;* tunúχkas *it thunders;* tunúχkaχtchi (abbr. tunúχka) imúngawats *it is frequently thundering* 21, 10; tunuχkáχtchun *which was thundering* 21, 5.

tû'skuli *elbow.*

tutchíni *three;* pokóli tutchínak and pokóli tutchínan *thirty*, lit. "three times ten" 20, 5. 9.

tchabánas, du. pubánas, pl. pubasnádshis *I like*, *desire*, *want;* ibasnā'dshik *desirous of*, *wanting to* 21, 3; tchabánatis and tchabátis *I do not like*, *am dissatisfied with;* ibasnā'dshitik *being dissatisfied*, *not liking* 20, 27.

tchá'hni, pl. tchá'htchúni *healthy*, *hale*, *well* 22, 6.

tchayokáhas *I am blazing up*, *I am on fire;* tchúyut yuχáhas *the pine-wood is burning.* Cf. ayokaháχtchi.

tchakahódshis; see kádshilis.

tcháχgipi *five* 20, 6. 10; tsaχgípaska *or five* 22, 3.

tchalamó·las *I become sick, fall sick;* lit. "I become changed." Der. lámo'li: cf. tamo'látchis.

tchama'lális; see ma'lális.

tchanä'plilis *I shoot, fire;* tsanä'plilis *I shot, fired.*

-tchángis, -tchákis, in tchatchákis *it comes upon me, overtakes me;* íntchäkis *it overtakes him, her, it, them;* ántchagin, tchatchákin *it having overtaken me,* said of time or sections of time; íntchagin, íntchangin *having arrived, come upon him, them* 21, 37.

Tchä'tcha, nom. pr., *State of Georgia.*

Tchätchä'·li, nom. pr. *Georgian, belonging to Georgia;* Tch. íyaχni *the Georgian territory* 20, 8.

tchá-ulilis *I write.*

tcheíhi, tchä'-ihi, pl. tcheitchóhi *high, elevated, lofty;* 'láni tchäíhi *mountain;* also expressed by yákni tcheíhi vol. i. 81.

tchigaχnádshilis *I pile up into a cone;* tchigaknádshik ómitî *they were piling, heaping up so* 22, 19.

Tchigasá·li, Tchikasá'li, nom. pr. *Chicasa Indian* 22, 19.

tchikasípahin; cf. wasákipalis.

tchíki, tchígi *house, lodge* 24, 24. 25, 4.

tchíkni, tchíχni, pron. pers. *thou;* tchíχnak *thou also;* often stands for *ye also,* for when one of the bystanders, as the chief, is addressed, all others are addressed also. When, as in 25, 15, tchíχnak is subject of the sentence, tchíknutak can stand for it.

tchiknitági, pron. pers. 2d pers. pl. *ye, you.*

tchî'kti, pl. tchiktchi'ti *thick,* said of liquids 20, 29.

tchipilídshilis, *I set* or *stick up in the ground;* tchipi'h-lítchilis *I did set up in the ground;* tchipi'hlí'htchik *by, after setting up* 22, 10; puχábi tchipi'hlitchígaχa *the poles set up* (by us) 22, 13. Cf. hadshalídshilis.

tchî'si *rat* 22, 29. 30. 33.

tchóba'htchi, pl. hō'ta'htchi *large, great* 21, 7. 22, 23.

tchóbi, pl. hō'ti, hû'ti *large, great, big;* composes isihótosi. okitchóbi, q.v.; tchúkbi=tchóbi 'lámin *one thousand* 20, 5, 9; mígi tchóbi *the king of Great Britain* 25, 34.

tcho'lólilis, du. tcho'lósligas, pl. tcho'loslídshigas *I pass, go, fall through*; ahopuskí tcho'h'lólik *having passed through the branches* 23, 25.

tchü'yi, tsúyi *pine; pine-wood* 23, 29.

tchúk'bi, tchúkpi, tchók'bi *hundred;* tchók'bi 'lámin *one hundred;* tchúk'bi kulapákin *seven hundred* 20, 5. 9; tchúk'bi= tchóbi 'lámin *one thousand*, lit. "great hundred" 20, 5. 9.

tchukúlilis, du. of subj. wingígas, pl. i'lígas 1) *I sit, I am seated.* 2) *I live, stay, remain; I reside, stay there; I am* or *exist there.* This verb, especially its plural form í'ligas, is often used as a mere auxiliary *to be* or *to exist*, and differs from the pl. ya-ulídshigas of singular áyalis only by the circumstance that the idea of *staying, remaining* inheres to it, while the other embodies *motion*, úmmilis the idea of being *such* or *so.* Tchoχulilitahúnga *where I have lived, dwelt;* tchokólik úmmigat *located, situated*, said of a mountain 24, 29. ī'liwats *it might be, exist, happen* 22, 28. alokúntilāχā í'liwats *when it should happen that they will approach* 23, 1; íliktawāts *they stopped, remained there* 20, 22–25; í'ligi *to remain there* 20, 33; í'lik fógi *while they were there assembled* or *seated* 21, 36; cf. 37. mún í'lik *settling down, stopping, remaining there* 20, 32; í'lik ummitúgas *must live, exist there* 24, 31; yán í'lik úmmihin *are residing there, at the same place* 25, 11; yán í'lin *living, remaining there* 23, 16; yátut í'lin u'látchik ákliktawāts *having come there they thought the* (same) *people was there* 24, 15; í'lin ní'htagi *next day*, lit. "a day being there (coming, in proximity)" 21. 37. 24, 12. 14. í'lihin *being there*, or *were there* 24, 34; *settling there* 25, 22. óklun í'lihin *a tribe staying* or *town situated there* 23, 16; apaluá'htchi í'ligan *those settled on one* .... *on the other side* 25, 23. í'liktchut ü'mmiwats *they were living together* 25, 21; í'liχt (for í'liχtchut) ü'mme-wats *does at times*, lit. "lives there in the habit of" 21, 23; i'lahúnka *where they had lived, their former residence* 23, 5; í'lihunga (same) 24, 8; i'liktahúngan *where they had been long before* 20, 24.

tchúnu'li *flint, flint-stone* 24, 6.

tchû'nusbi *heart;* púdshunusbi *our hearts* 25, 15; tchúnus'=hi'lalátik *restless*, lit. "troubled-very-at-heart" 21, 24; cf. hí'latis.

ú'hmisis *apparently, seemingly* 24, 36. For the structure of that sentence, cf. úmmilis (2).

U-i=túmki, nom. pr. of *Wetumpka creek*, Eastern Alabama, 24, 12. and p. 65.

-ukma; cf. ú'mmigma.

ukólis, okólis, in anukólis *I am alone;* pu'hnukólis *we* (and we two) *are alone;* anokólosik adshálaχkis "I only am left alone."

ukúli=ka (for ukóli aka) *nothing but, just* (this) *alone;* pí-tchiktch=ukúli=ka *nothing but blood on, blood being smeared all over* 25, 16; yáti wántak ukólik (abbr. wántak=uk) *only strong people.* Cf. ukólis.

ukúlintchi, hukúlintsi *busk* or *fast;* in Creek, púskita.

ú'lalis; see ó'lalis.

umhá'hmis 23, 19; see úmmilis (2).

û'mmiga, ómiga *alike to, resembling;* lit. "for being so, for doing so." pítchiktch=ómika *looking blood-like* 21, 1; há-yak ú'mmiga "*ripe-looking*," *ripe* 21, 38; naχnosót úmmik *ancient, old*, in the sense of *brave;* lit. "ancient-alike to" 22, 7. náχot û'mmiga atá'ligun *in order to know what it was.* lit. "what-like it was" 21, 6. For û'mmik 25, 28 see úmmilis (1); táli ayógaχtchut ómmig *being rocky*, lit. "rock-underlaid-looking" 23, 13; hí'lut û'mmika *good*, lit. "good-alike" 24, 17; tchokólik û'mmigat *situated*, lit. "seated-alike" 24, 29; hídshkak û'mmekat *was visible, perceptible.* lit. "visible-alike" 24, 25; û'mmigan *as it was* restless and noisy, lit. "restless-resembling" 21, 25.

ûmmigáyi, ûmmigá-i *alike to, resembling;* same as û'mmiga. lubulídshin ummigá-i *acting so as to cover it over*, lit. "looking like covering it" 22, 14; alokúntin ummigáyi *approaching as such one, in such an attitude* (as previously described) 23, 3. Der. úmmilis, áyalis.

ú'mmigma, contr. -ukma *though, although* 22, 16; laknû't û'mmikma *although it is yellow* 22, 10; gitistch=ukmá *although it was red* 21, 21.

úmmikus, ómikus *may be, probably* 23, 11. Der. úmmika, hōs.

ú'mmiχtchi, ómiχtchi *looking like, resembling*, lit. "being so"; ma umíχtchut *like it* 21, 30; pítchiktch=úmiχtchi *bloodlike* 20, 32; átasi omíχtchut *like a war-club* 21, 29. Der. úmmilis.

úmmilis, ómilis 1) *I do* or *act so; I perform, act, do; make, manufacture.* umhá'hmilis *I did so, have done so;* a'ládshiχtchut ú'mmiktawāts *they travelled thus habitually* 24, 38; hítchgatīn ómmiktawāts *they made it so as to be invisible* 22, 18; 'lági ú'mik *making arrows* 24, 17. ómik *manufacturing* (arrow-heads) 24, 17; ú'mik *manufacturing* (bows) 24, 6; tä'g=ábun ómig *making a woman's likeness* 22, 25; ómik áyi, ú'mmik á-i *when he moves about, whichever is going along;* cf. úmmigáyi ú'mmik fógi *when, after doing so; after that event* 25, 3. 4. ú'mmi'htchi, ómiχtchi *the one making, those who made, the maker or makers of* 24, 15. 35. (Also means *looking like*, cf. ú'mmiχtchti.) ómihin *doing so* 22, 34; ómiti *as, because they did* 22, 18; yátun pumanóliχtchut ommi'h-tchámas *has devoured our people*, lit. "devouring people away from us he has been doing so" 23, 18. Cf. quotation under sonába. úmmiktá'htchuti *as they had formerly* (-tá'h-) *built, constructed* 25, 28.—2) *I am such, so; I am thus; I am.* This verb is extensively used to form periphrastic conjugations with verbals and a number of particles, and comes nearer than any other Hitchiti verb to our substantive verb *to be;* but the function of *being such* or *so* is always perceptible. Very frequently the idea of *habitude, custom, permanence* is embodied in its use. ú'mmis, ō'mis, ómis *it is he, she, it; so it is* 20, 2; *so they are.* ya-ulídshik ú'mmis=aχá (what kind of people) *could have been there* 23, 10; cf. 23, 9. mí'ki tchóbut ómmís *that he is a great chief* 22, 36; umhá'hmilis *so I was;* afóksak umhá'hmis (ellipt. ú'mhamis) *he was inside* 23, 19: ómiwats *it was* (of the same wood) 21, 31; ómmiwats *is so*, viz. "it is a sign, token of" 23, 1; yátut úmmiwats *it was the same people as* 24, 16;

ak'hóliχtchut úmmiwāts *it is commonly believed, supposed* 24, 31; inhág'liχtchut úmmiwāts *they are hearing it* each time 24, 32. isiaúlidshi'ht úmmiwats *they habitually take it along with them* 21, 29; cf. ómiwats 21, 37: also used in the sense of "customarily": û'mmewāts 21, 11. 23; wäíli'htchut u'mmiwats *they were wont to make offerings* 22, 1. u''hmisis — the sentence runs as follows: "those who busied themselves (ya-uli'htchigat) in making the white path had *apparently been* (u''hmisis) about there," they thought 24, 36. mámut û'mmitis *let it be so* 22, 9. yáti ilístchiχtchud úmmiktawāts *was wont to kill people* 23, 34; úmmiktawāts *so* (yellow) *it was* 21, 21. ómiktawats (same) 21, 29. ummiláχas *it will be* (the most prominent tribe) 22, 14. í'lik ummitúgas *it seems to* or *it must live there* 24, 31; corresponds to Creek omátchukis, contr. omádshuks. ómik=fógi i'lídshik *whenever they are possessed of*, or *in case they have*, or *wear* 23, 2 (ómik, *it being so*, *as it is so*). yán í'lik u'mmihin *there they settled* or *lived then* 25, 11. yátut ya-ulídshi=hí'lut úmmihin *that people had surely been there* 23, 7. ómmiti "as it is so": pafáksiχtchut ómmiti *as it was smoking* 23, 13. û'mmiti 22, 11; see kitistchádshilis. wátulût u'mmiti *on account of cranes being there* 24, 10. úmmiχtchi, ómiχtchi *alike to*, lit. "being, having been so," q.v. hátgut úmmahúnga *if they had been white* 24, 21.

û'mmiska *although, nevertheless;* húndshitik úmmiska *nevertheless they do not leave, give up* 25, 29. Der. úmmilis, -ska.

umpí'lbalis (for unpí'lbalis) *I throw over, on the top of;* imû'mpi'lpahin *then they threw over to* (his den) *for him* 23 24. Der. pī''lbalis.

un-, uⁿ- prefix signifying *above, over, on the top of.*

unábaka *from that time, since then* 25, 21.

unadshálilis, du. unloχógigas, pl. unloχoskádshigas *I stand upon, on the top of;* unadsálik û'mmigat *which was standing upon* 21, 24. Der. hadshálilis.

unálilis, pl. unā'ligas *I tell, speak about, disclose;* onálihin *then telling, disclosing* 21, 33.

unalobídshilis *I cover up, I cover* something *over;* unalobídshik *having covered* (it) 23. 29.

una'lalí'htchi *cascade, chute of waters;* oki-tchóbi una'láli'htchun *fall of a river* 24, 11; óki una'lalíχtchun *a fall of waters* 24, 33. Der. una'lálilis.

una'lálilis, du. una'laslígas and una'lisyígas, pl. una'laslídshigas *I fall upon, on* something; una'lálihin *and having tumbled into* 23, 28.

una'líyalis, du. of subj. una'líshiyas, pl. una'lyádshigas and una'ládshigas *I go towards, approach;* una'ládshiktawats *they approached it* 21, 3; unati'lyaχtchátchkis *ye must not approach* 24, 22; (mark the position of the negative -ti- at the beginning of the word!) una'ládshik *going towards it* 23, 23; *going there* 24, 21; una'ládshi-yámiktawats *some of them* (yámika) *approached to* 24, 24 (instead of: yámika una'ládshiktawāts).

û'ngaχtchi *emitting sound, noise; alike in sound, voice* 21. 2. 23, 3. 24, 30; húpanaχtch-û'ngaχtchi *something that sounded like singing, like a chant* 21, 6; hant-úngaχtchi *noisy* 21, 25. únga'ht (for únga'htchut) úmmiwats *it usually sounds* like 24, 30. Partic. of únkalis, q.v.

úngi *noise, sound, clang;* Watúli-úngi há'htchi *Crane-whooping creek* 24, 8; únga kádshiga *calling it "noise, whooping"* 24, 9. Cf. únkalis.

ungómihin 21, 8: stands for û'ngak û'mmihin *and producing a sound alike to, being alike in sound to;* cf. únkalis.

únkalis, û'ngalis 1) *I produce sound, make noise; I halloo, vociferate.* hapónik û'ngaktawats *they made speeches,* lit. "they were noisy in speaking" 21, 2. úngak *producing a sound* 21, 8; hupanî''htch-ungómihin (or, úngak u'mmihin) *like the sound of singing* 21, 8. handû'n úngahōs, for hantún úngak úmmihōs, *whence it might sound, where it sounds from* 21, 3: 2) *I say, tell; I call by name.* û'ngaktawāts *they called it* 23, 14; cf. hodshífalis; únkakat *were telling, saying so* 23, 17; úngakat 23, 20. Cf. íngalis *I speak.*

un'laníyalis, un'laníalis, du. un'lanishí-igas, pl. un'lanisyádshigas *I ascend, mount;* un'lanishíakan *two having ascended* 25, 1. Der. 'laníyalis.

un'linígalis, du. un'linísi-igas, pl. un'linisyádshigas; also, du. unpalákigas, pl. unpaláskigas, unmutágigas 1) *I run over it;* 2) *I run towards it.* un'linígak *having run towards* (the motherless child) 23, 28.

u'nsalik 23, 22; see untalálilis.

unsalkádshin 24, 34; see untaláχalis.

untaká'lilis, pl. of obj. untaχás-'lilis *I send out* or *dispatch towards;* untakás'liktawats *they sent out there,* yátun more than one *man* 21, 7.

untaláχalis, nasalized untaláugalis, du. unsalgákas, pl. unsalkádshikas *I lie upon, I am stretched out upon;* unsalkádshin *lying thereon* (pl.) 24, 34.

untalálilis, pl. of obj. unsánlilis, unsálilis *I lay over, on the top of; I superimpose.* û'nsalik *having laid over* 23, 22. Der. találilis.

úntilis, du. uláwīgas, pl. úntidshīgas *I come, arrive from;* û'ndiχtchut *coming from* 21, 17. 18. 19; úntiχtchut (same) 21, 19; úntigat *came from* 21, 21; untilíχtchush *I come from there.* Cf. adshakúntilis, alokúntilis.

untcha-úlilis *I write down upon, paint, mark upon;* undsha-uhóliktawāts *it was written upon* (aor. passive) 20, 7. Der. tchá-ulilis.

utchabosiχtchi *very young.*

utchá'hbi *young.*

û'tski 1) species of *reed,* thicker than the common reed in the south; 2) *reed-brake, swamp* or *canebrake* where the û'tski-reed is growing; 3) *smoke* 21, 4. 25, 27.

u^{n}weígalis, du. u^{n}weígigas, pl. u^{n}weigádshigas *I surpass, excel; I am ahead of, I overcome.* wäíkak, weígak, for u^{n}weígak: *in excess, in addition to, besides, with it, over it;* used as a classifier with numerals from one to nine; tchaχgípa-weígak, tcha'hkípa-wäíkak or wäíkan *five more* 20, 6. 10. Cf. i. 81.

wā'dshi *mother;* cf. áχki.

waháli *south;* original meaning, "down stream," cf. Note to i. 85. 190. wahálun û'ndiχtchut *coming from the south* 21, 18.

wasákipalis, du. wasaskípigas, pl. tchikasípigas *I am lost, gone;* tchikasipahin *then they were gone* 24, 24.

wátuli *crane* 24, 9; wátuli=úngi, lit. (producing) "crane's noise," *whooping of crane;* also name of a water-course 24, 8.

wäílilis, abbr. from uwäílilis; du. and pl. of subj. wäíligas 1) *I offer, hand over to;* wäilí'htchut û'mmiwats *they are in the habit of offering* 21, 38; ă'sun iwäílik or (i-uwäílik) *tendering to them* (i-) *the black-drink* 25, 14. 2) *I offer for sale, I sell.*

weígak, wäíkak, for uⁿweígak; verbal of uⁿweígalis, q.v.

wíktchi, pl. opóski *small, little; thin.* Cf. ahopóski, hupóski.

wiktchusíχtchi, abbr. wíktchosiχt; pl. opóski—same as wíktchi, q.v.

witíχkalis (unusual; occurs in) tsawítiχkas, du. puwítiχkas, pl. puwitiχkádshis *I am angry;* tchawitíχkalis *I become angry;* witíχkak *having become angered, wroth* 20, 22; witíχka'h=hí'lut *very angry,* lit. "angry-good" 23, 24; witiχwógak (redupl. form) *angered* 25, 3.

APPENDICES.

I.—WM. BARTRAM'S LIST OF MASKOKI TOWNS.

From his "Travels," pp. 462–64 (Philadelphia, 1791).

"List of the towns and tribes in league, and which constitute the powerful confederacy or empire of the Creeks or Muscogulges, viz.: *Towns* on the Tallapoose or Oakfuske River, viz.—Oakfuske Upper, Oakfuske Lower, Ufale Upper, Ufale Lower, Sokaspoge, Tallase Great, Coolome, Chuaclahatche, Otasse, Cluale, Fusahatche, Tuccabatche, Cunhutke. These speak the Muscogulge or Creek tongue, called the Mother tongue. Mucclasse; Alabama; speak the Stincard tongue. Savannuca; speak the Uche tongue. Whittumke and Coosauda; speak the Stincard tongue.

"*Towns* on the Coosau river, viz.: Abacooche; speaks a dialect of Chickasaw: Pocontallahasse, Hiccory Ground (trader's name), speak the Muscogulge tongue; Natche, speaks Muscogulge and Chicasaw.

"*Towns* on the branches of the Coosau river, viz.: Wiccakaw, Fish Pond (trader's name), Hillaba, Kiolege; speak the Muscogulge tongue.

"*Towns* on the Apalachucla or Chata Uche river, viz.: Apalachucla, Tucpauska, Chockeclucca, Chata Uche, Checlucca-ninne, Hothletega, Coweta, Usseta (should be Cusseta), speak the Muscogulge tongue; Uche; speaks the Savannuca tongue; Hooseche; speaks the Muscogulge tongue; Chehaw, Echeta, Occone, Swaglaw Great, Swaglaw Little; speak the Stincard.

"*Towns* on Flint river, comprehending the Siminoles or Lower Creeks, Suola-nocha, Cuscowilla or Allachua, Talahasochte, Caloosahatche. The following are traders' names: Great Island. Great Hammock, Capon, St. Mark's, Forks. The Siminoles speak both the Muscogulge and Stincard tongue.

"In all fifty-five towns, besides many villages not enumerated, and reckoning two hundred inhabitants to each town on an average, which is a moderate computation, would give eleven thousand inhabitants."

II.—TOPOGRAPHIC LIST OF THE CREEK TOWNS AND VILLAGES.

As a help for the study of Creek topography, I add the list of Creek towns as found in Caleb Swan's Report on the "Muscogee nation" in 1791, and printed in Schoolcraft's "Indians," v. pp. 262–63. It gives us the true topographic[1] order in which these towns followed each other from North to South.

"The smallest of their towns have from twenty to thirty houses in them, and some of the largest contain from 150 to 200, that are tolerably compact. These houses stand in clusters of four, five, six, seven and eight together, irregularly distributed up and down the banks of rivers and small streams; each cluster of houses contains a clan or family of relations, who eat and live in common. Each town has a public square, with hot-house and yard near the centre of it, appropriated to various public uses.

"The following are the names of the principal towns of the Upper and Lower Creeks that have public squares, beginning at the head of the Coosa or Coosa-hatcha river, viz.: 1. Upper Ufalas, 2. Abbacoochees, 3. Natchez, 4. Coosas, 5. Oteetoochenas, 6. Pinclatchas, 7. Pocuntullahases, 8. Weeokees, 9. Little Tallassie, 10. Tuskeegees, 11. Coosadas, 12. Alabamas, 13. Tawasas, 14. Pawactas, 15. Autobas, 16. Auhobas, 17. Wetumpkees, big, 18. Wetumpkees, little, 19. Wacacoys, 20. Wacksoyochees.

"Central, inland, in the high country between the Coosa and Tallapoosa rivers, in the district called the Hillabees, are the following towns, viz.: 21. Hillabees, 22. Killeegko, 23. Oakchoys, 24. Slakagulgas, 25. Wacacoys.

"And on the waters of the Tallapoosee, from the head of the river downward, the following, viz.: 26. Tuckabatchee Teehassa, 27. Totacaga, 28. New York,* 29. Chalaacpauley, 30. Soguspogus, 31. Oakfuskee, 32. Ufala, little, 33. Ufala, big, 34. Sogahatches, 35. Tuckabatchees, 36. Big Tallassie or half-way house, 37. Clewauleys, 38. Coosahatches, 39. Coolamies, 40. Shawanese or Savanas, 41. Kenhutka (in text, Kenhulka), [40 & 41. Shawanese Refugees,] 42. Muckeleses.

* Named by Colonel Roy, a New York British loyalist.

"Of the Lower Creeks, beginning on the headwaters of the Chattahoosee and so on downward, are the towns of: 43. Chelucconinny, 44. Chattahoosee, 45. Hohtatoga, 46. Cowetas, 47. Cussitahs, 48. Chalagatsca or Broken-arrow, 49. Euchees (several), 50. Hitchatees (several), 51. Palachucla, 52. Chewackala.

"Besides nearly twenty towns and villages of the little and big Chehaus, low down on Flint and Chattahoosee rivers, the names of which I could not ascertain."

III.—THE CREEK TOWNS OF GEORGIA.

Extract from J. Gerar William de Brahm "History of the Province of Georgia; a manuscript from the 18th century, preserved at Harvard Coll. Library, Cambridge, Mass. (parts on S. Car. and East Fla. still unpublished); printed at Wormsloe, 1849, fol. In first part of publication are many Creek names of localities; pp. 54 and 55 contain the following:

"Towns of lower settlement or Lower Creeks: Tohowogly and Cawita, between 8 and 10 miles below Cataract of Chatahoochee river. Little Tallesy and Owetomkee old Town, on Coosaw river (p. 55:) N.W. of Fort Alabama: Owetomkee New Town, Mukelossa, Savannow, Coolame, White Ground, Fegoskatchee, Clually and Ottosee towns below the first cataract of Locushatchee now Talepusee river, Nophabee, Tukasatchee and Tallesee are towns between first and second Cataract. Hughphala, Lustuhatchee, Oakfusky, Alkehatchee, and Suchutspaga towns above the second Cataract of Talepusee. Cojolegee and Oakjoy are towns upon Cojologee, a Rivulet of Talepusee river; Oktosawsee and Hillawbes, towns on Oktosawsee (all on O. river are Upper Creeks)."

It is of importance to notice that this useful list is disfigured by many incorrect names, the miswriting being due either to the author himself or to ignorant proof-readers: Towohogly for Sawokli, Locus-hatchee for Socushatchee, Tukasatchee for Tukabatchee. "Georgia" then comprised a broad strip of territory extending from the Atlantic ocean to the Mississippi river.

IV.—THE CONTEST FOR LEADERSHIP

among the four ancient tribes of the Creek people, the Kasi'hta, Chicasa, Alibamu and Abi'hka, is recounted in the legend. pp. 10, 38 to 12. 12. Further information which I received from chief Ispahídshi on legends concerning his own tribe, which is that of the Kasi'hta, induce me to believe that this story is simply the result of an etymologic deduction from the Creek word ábik'hi *piled up against*, which is a participle of the past of abik'hídshäs *I pile up against*. The contest between the tribes in obtaining the scalps was recounted by him in the same manner as in our legend. The pole around which the scalps were piled up is described as *very tall*, to make the story more miraculous. Cf. vol. i. 125.

The legend, as recounted by Ispahídshi, further relates that the Kasi'hta and Chicasa people came out of the ground somewhere in the west; and that the Kawíta issued from there somewhat later, because a large root growing across the orifice retarded at first their coming out. The Kasi'hta then proceeded from the place of issue towards the east to see the cave or hollow "from which the sun emerges." All these statements are merely etymologic deductions or inventions just like the above: Kawíta being derived from awíta *to come* (plural of subject), Tchíkasa from tchikáṣki, a Creek verbal ("opening out" like a flower), Kasi'hta from hásin hídshita "*to see the sun*" coming out.

That the first and third of these etymologies are grammatically impossible will appear at once, and the name of the Chicasa people has to be deduced from some Chicasa or Cha'hta term in preference to any one occurring in the Creek dialect. We gather from this and many other instances, that *false etymologies* have influenced the myth-making tendency of humanity at an early age in the western as well as in the eastern hemisphere; and it may be added, that the idea of the sun issuing from an orifice in the earth and disappearing through another, is found among several of the North American tribes. Cf. ii. 27.

Each of the four leading towns of the Creeks had an honorary title or epithet, the origin of which is uncertain and obscured by later traditions reposing on fictions. Abi'hka was called nági, and Tukabá'htchi ispokógi, none of which the present Creeks can explain satisfactorily on account of their archaic character. The Kawita Indians were called ma'hmáyi *the tall ones* (cf. máhi, p. 107), and the Kasí'hta 'láko, the *great* or *considerable*. The latter epithet may be compared to our *grand* in *grand duke*, *grandissime*, etc., and, when speaking of Kasí'hta, was not employed in the plural form 'lák'lagi, like ma'hmáyi, which is a term analogous to the French *Altesse*, and the German *Hoheit*, *Hochwürden*.

V.—LIST OF TOWNS NOW EXTANT IN THE CREEK NATION, INDIAN TERRITORY.

The forty-nine towns enumerated below constitute what is called the Creek Nation of Indians settled on a wide strip of territory between the Arkansas and the Canadian river, a large tributary of the Arkansas river. The term *town* is the translation of the Creek term tálua, which also means village and city, but corresponds more closely to our term *tribe*. But, since *several* tribes are often included in one Creek town, it is preferable to interpret the term by *township*, and some of these towns have an area as large as a good sized county in a western State. Each town is entitled to *one* representative in the Upper house, or House of Kings, and to *one* at least in the Lower house, House of Warriors or Representatives; towns having over two hundred men are represented by one more deputy to each two hundred in this Lower house. The largest and most populous town is now Yuchi on Arkansas river; the negro towns, the inhabitants of which descend from slaves who emigrated with the tribe from 1836 to 1840, possess from 3,500 to 4,000 inhabitants, and their representatives now hold the balance of power in the Creek legislature, which meets annually at the capital, Okmulgee.

Here follows a list of the present *Creek towns*, the smallest of which have now barely twenty heads of families, but nevertheless are represented as "rotten boroughs" in the two Houses by one deputy for each. The Lower House now counts about one hundred members. All the settlements are spread out upon rivers, creeks and streams, and the intervening country is almost entirely devoid of them.

Ábi'hka; settled at three places: north of Yufála, on Deep Fork west of Niuyáχa, and north of Hílabi.

Abi'hkúdshi, or Little Ábi'hka, on Deep Fork above Okmúlgee.

Akfáski, or Okfuski, on Deep Fork near Canadian river junction, and another settlement near Niuyáχa.

Alibamu, on North Fork, along middle course.

Arkansas river *colored* town, between Caney Creek & Muscogee.

Ássi lánapi, on Alabama Creek.

Átasi, on Deep Fork, west of Okmúlgee.

Canadian River *colored* settlements and town.

Hátchi tchápa on North Fork at influx of Alabama Creek.

Hílabi, southwest of Yufála No. 1, between North Fork and Canadian river.

Hítchiti, on Deep Fork, half-way between Yufála and Okmúlgee.

Hú'li=Wá'hli, abbr. 'Liwá'hli, on North Fork above Hilabi.

Yuchi, south of the Arkansas and its affluent, the Cimarron river, from Cane Creek to Big Pond, on the western border of the Creek territory.

Yufála No. 1, town and railroad station near North Fork and Canadian river junction.

Yufála No. 2, town near Okmúlgee, on southern side of Deep Fork. Each of the two Yufálas calls the other: Yufála hupáyi, "the distant Yufála."

Ka-iläídshi, on Canadian river, east of Hílabi.

Kanshádi, Ikan'=tcháti, spelt Conchanti, between Cane and Caney Creeks, southwest side of Arkanas river.

Kasí'hta, on Deep Fork, west and east of Okmúlgee.

Kawíta, north of Arkansas river and west of Fort Gibson.

Kítchu patáki, on the point of land formed by the confluence of Deep Fork and North Fork.

Koassáti No. 1, west of Hílabi town.

Koassáti No. 2, a few miles west of Yufála No. 1.

Lutchapóga, east side of Arkansas river, north of Wialáka.

'Lá'lo akálga, or Fish Ponds, near Hílabi, between North Fork and Canadian river. (G. W. Grayson: on Alabama Creek.)

'Láp 'láko, north side of North Fork, on Alabama creek.

'Lé kátska, once a colony of the Kawíta; now on Arkansas river, almost opposite to Wialáka and near Kawíta.

Niuyáχa, south side of Deep Fork, about 96° 20′ west of Greenw.
North Fork *colored* town.

Odshi-apófa, or Hickory Ground, on North Fork below Alabama Creek junction.
Oktcháyi, on Canadian river, near Hílabi town.
O'sudshi, on Deep Fork, below Okmúlgee.

Pákan꞊Talahássi, on Canadian river, below Hílabi.

Taladígi, on Canadian river, southwest of Hílabi.
Talahássudshi or "Little Talahássi," town on Canadian river, north shore, about 18 miles west of Yufála No. 1.
Talmotchási, near Canadian river, east of Hílabi.
Tálsi, at the Old Creek council-ground, west of Uktaha railroad station.
Tálsi, at mouth of Little river.
Tálua 'láko, on North Fork, junction of Alabama creek.
Taskígi, 10 miles west of Yufála No. 1.
Taskígi on Deep Fork, west of Okmúlgee.
Tukabáχtchi, north side of Wiwúχka river; migrated there from a place midway between Yufála No. 1 and Hílabi.
Tukpáfka, on Canadian river, about 8 miles below Little river influx.
Tcháχki 'láko, near junction of Deep and North Forks.
Tchat꞊aksófka ("precipice"), town one mile southeast of Yufála No. 1.
Tchiáha, or Chíaha, on Verdigris river, northeast of Wialáka.

U-i꞊káyi 'láko, between Tulsa station (on Arkansas river) and Verdigris river.
U-i꞊ukúfki, above Hílabi town.

Wakoká-i, near Hílabi town.
Wiwúχka, south side of Wiwúχka affluent of North Fork.

[Tálsi (abbr. from Talahássi), or Tulsa, another name for Lutchapóga town.]

VI.—THE TOWN-SQUARE OF THE CREEK INDIANS.

Although the diagram appended intends to represent the town-square of Kasi'hta town in particular, it may be regarded as an *average* reproduction all of the town-houses, or tchúko 'láko, as found to exist at the present time in the few settlements of the Creek Nation, Indian Terr., which have preserved the antique institution of the busk or púskita.

The four sheds are rather low and of equal size and construction, each facing one of the four points of the compass; the roof rests on five supports, and thus each shed is divided into four parts. The front of each measures about forty feet, and open passages are left between. Each shed stands upon ground sloping forward, is open behind, and on its floor contains from twelve to fifteen logs running parallel and intended for seats. The sheds or túpa, lit. "scaffolds," are entered from behind; the space under the seats is reserved for the storage of objects needed during the celebration of the busk, which formerly lasted eight days, but is now in several towns reduced to six or even four days.

The council-house, rotunda, or tchukófa 'láko, where meetings were held only in winter and during bad weather, is built into the southern end of the western shed, and a road leads from its door to the square and fireplace, upon which the people often moved in file or procession. South of the southern shed is the tádshu or area surrounded by an earth-wall, where games and dancing have full sway. In the town of Tukabatchi this area lies behind the western shed. The four logs which feed the sacred fire lie in the centre of the square, and each in the direction toward one of the points of the compass.

The sheds and partitions assigned to each of the gentes and divisions of the people vary greatly from town to town. Tálua 'láko, now the only busking town of the Hitchiti connection, disposes them, according to G. W. Stidham, in the following order: the western shed is assigned to the míkalgi; the south shed to the tassikáyalgi, familiarly called *boys;* the east shed to the women and children; the north shed to the tastenakálgi or "warriors." The details of the present diagram refer to the square of Kasi'hta town on the Deep Fork of Canadian river, and were obtained from chief Ispahídshi, who is a native of that town, and well acquainted with its present and earlier customs.*

* Compare the ground-plan of the square and "great house" in Odshi-apófa by C. Swan (1791) in Schoolcraft, Indian Tribes, v. 264.

Following his indications, the seats of the KASI'HTA SQUARE are occupied as follows during the busk festival: The western partition of the *northern shed* is held by the warriors or tustĕnákis, the three others by the wild-cat, fox, panther, and itamálgi gentes. The front seat in the westernmost corner is occupied by the hú·li opunáya or *war-speaker* (⚔), who had to be consulted on war questions and military matters, and has been compared to our "Secretary of War." The other seven front seats next to each partition pillar (+) are held by busk officials called imá·la, who had to act as masters of ceremonies. Two pots filled with míko-huyanidsha stand in front of the shed upon the area of the square.

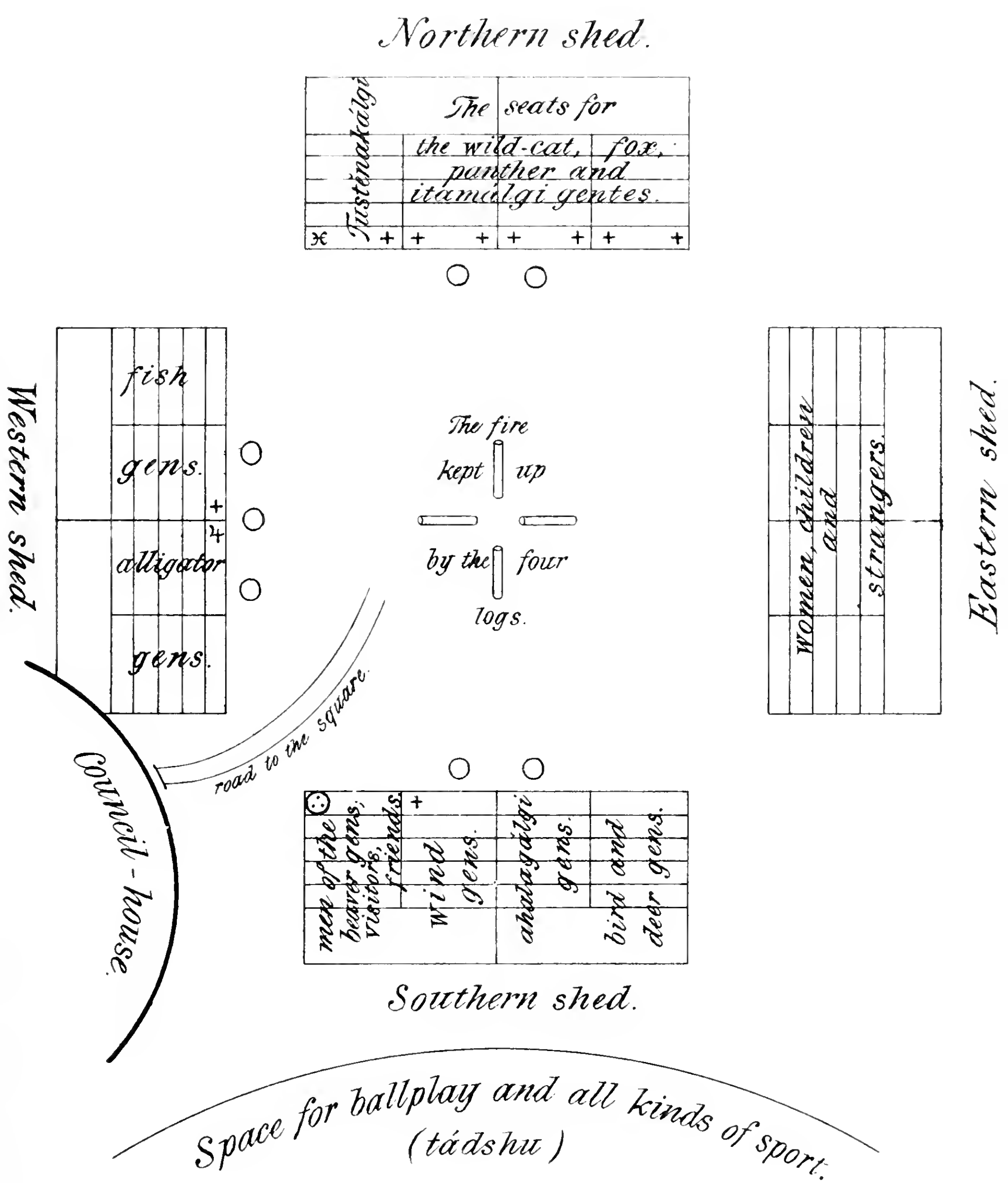
In the *western shed* one of the middle front seats is occupied by the town-chief or míko (♃), who among the Kasí'htas is always selected from the bear-clan or nokusálgi. Immediately to the north of him sits the vice-chief (+), who is elected from the bear-clan also. Around and behind these dignitaries the men of the alligator and of the fish gens are occupying seats. Three pots of black-drink, etc., are placed in front of this shed.

The western front seat of the *southern shed* is assigned to another dignitary, called Kósi míko (☉), selected from the beaver gens exclusively. He and the tálua híniha 'láko, or "grand híniha of the town," who sits in the partition corner next to him (+), had the privilege of appointing another míko in case of death or incapacity, provided the two agreed upon the same person. They tried by their most suggestive means of oratory to persuade him to accept the office; afterwards he was silently recognized as chief by the whole community. In the same shed are sitting, in succession from west to east, the men of the beaver, wind, ahalakálgi, bird, and deer gens. Two pots stand in front of the southern shed.

The *eastern shed* is not occupied by any officials, but reserved to women, children, and strangers. No medicine-pots are placed in front of this shed.

On the last day of the busk dancing is going on between the northern and western sheds. During the festivities the men dance around the fire in the central part, and then women are not admitted there, though they are on other dance-occasions. The

Diagram of the Kasi'hta town-square.



mixed-bloods usually do not participate in the busk-festivals. which generally occur in July.

After the participants have arrived and made themselves ready on the first day, the *second day* of the Kasi'hta busk becomes the great joyful day for young and old. Being a sort of *mardi-gras*, it is called by the Creeks the "day of all-day eating," or níta húmpi isyáfkita. Since men are detailed for almost every conceivable ministration connected with the busk, the chiefs send out on the morning of the second day four men for logs to kindle the "new fire." They cut them as large as each man can carry, and deposit them on the four corners of the square. where they have to remain for that day. Then the logs are brought together with their ends so close as to allow the fire to burn between them, and on the last day everybody has to take home some of the new *sacred* fire (called so because kindled ceremonially), and extinguish the old fire upon his fireplace.

The rest of the busk ceremonies in the Kasi'hta square are described in vol. i. pp. 177–80. Particular war-symbols, called atássa=aháki, are standing in the square of a few of the busking towns; they are described in the Creek Glossary.

In the square of Tukabatchi town are preserved the *metallic plates* (in Creek, tchátu láni pulútpuki), referred to vol. i. 147. described and figured in Schoolcraft, Indian Tribes, iii. 87–90. and in Pickett, History of Alabama. i. 85. At every busk they are exhibited to the people *from a distance*, then washed in a stream and carefully rubbed and cleaned. They are said to utter spontaneously, without being struck or touched, a miraculous ringing sound.

The Creek towns still keeping up the institution of annual "busking" in their town-square are: Kasi'hta, Abi'hka, Niuyá'za, Assi lánapi, Átasi, Akfáski, Odshi-apófa. Tukabátchi. Busking towns speaking *other* languages than Creek are Alibamu, Tálua 'láko, and Yuchi.

VII.—THE CREEK TOWNS

which participated in the Indian insurrection of 1813 and 1814 against the United States government. or. as the Creeks express it, which "made themselves red" (itchatidshálgi), are enumerated in the list inserted in Alb. James Pickett, History of Alabama, Charleston, 1851, i. 267, the names being given in my phonetic alphabet:

Hú'li⸗Wá'hli, Fús'⸗hátchi, Kulúmi. Ikanhátki. Sawanógi, Mukläsa, Odshi-apófa, Oktchoyúdshi, Pótchus'⸗hátchi, Pakan⸗talahássi, Wakokáyi, Wiwúẓka. Hawkins adds to these the Alibamu towns (Appendix to Sketch, pp. 83, 84).

According to my Creek informants, the above Upper Creek towns were reinforced by a few Yuchi living among the Upper Creek towns, also by a few men from Oki⸗tiyákni and Sáwokli, who are Lower Creeks. The Lower Creeks, Cheroki and Cha'hta sent auxiliary troops to combat the insurrection, the latter having as a leader the celebrated chief Pushmataha.

VIII.—LOAN-WORDS IN SOUTHERN LANGUAGES.

The present selection contains a list of words found to be held in common by two neighboring families of southern Indians, and by their incorporation in these languages proving an ancient contact of the two national bodies. For tracing contacts of this nature and thereby giving a clue to the ancient abodes and migrations of nations, *loan-words* are among the most useful historic documents, especially where they distinctly prove which nation or tribe has been the loaner and which one the borrower. Loan-words are chiefly terms for objects of international exchange, for plants and trees, and for animals hunted by man; and most of them must have been borrowed many centuries ago.

If by the present list it can be made probable that Maskoki tribes have many loan-words common with other southern nations east of the Mississippi river, this will help to prove, as well as the similarities in phonetics, that these tribes have been neighbors to each other for many centuries, and in the same tracts which they held when they were first visited by white men.

YUCHI-MASKOKI LOAN-WORDS

are not unfrequent, and with many of them the priority of possession seems to be decidedly on the Yuchi side. Their considerable number goes to show that the Creek branch of the Maskoki nation had pushed over to Savannah river and vicinity at a very remote epoch.

-ahá, -há, collective ending of substantives, is also coll. ending in Alibamu and Koassáti.

fá *side*, *direction;* -fa is suffixed to all names of the cardinal points. Cr. fátcha *straight*, *direct;* fátchan *towards*.

hí'li *smooth;* Cr. and H. hí'li *good*.

howitá, húta, hodá *wind*, *gust;* hó-itale *windy;* hotekewíwi *stormy*. Cr. hútali *wind*, *hurricane;* cf. há-utu *wind* in Caddo.

ihó, t'hó *potato*. Cr., Hitch. and Cha'hta áhi, áhe *bog-potato*.

láti in tsélati *I fall on you;* hílati *fallen down*. Cr. látkäs *I fall;* u'hlátkäs *I fall upon*, *attack*.

'lá 1) *arrow*. 2) *ball*, *bullet;* sé ti'lá *arrow* and *cartridge*. Cr. 'lí *arrow*, *ball;* Alibamu and Koassáti 'lakí *arrow* and *ball*. The probable original meaning of 'lí is *reed*, as arrows are made from reeds.

pi'ló *cylindric;* tí topi'ló *I roll up something*. Cf. Hitch. pí'li and dimin. pí'ludshi; Cr., Semin. and Mikasuki pi'lúdshi; Cha'hta péni, píni; Alibamu and Koassáti pi'lú *canoe*, these being round below.

tápi *salt;* tápi sä^n *sweet*. Cr., Alib. and Koassáti hápi *salt*.

tchissané *mouse*. Cr., Alibamu and Hitch. tchíssi *rat*, *mouse*.

[tchúli *pine-tree;* tchú *boat*, *canoe* (because made of pine-logs); Cr. and Seminole tchóli; Alibamu, Koassáti and Hitchiti tchúye, tchúyi; see below.]

CHEROKI-MASKOKI LOAN-WORDS.

The majority of Cher. terms here mentioned were obtained from Mr. James Mooney, who, in 1887, studied the dialects of the mountain or eastern Cheroki Indians in North Carolina. To these may be added the ones mentioned in vol. i. pp. 212–13.

áta *firewood*. Cha'hta íti *wood*, *stick;* Cr. ítu *wood*, *firewood*, *tree;* Hitch. íti *fire*, originally *wood*. Áta occurs for *wood* in the Iroquois dialects; cf. tá'hsi.

kóe, kuhé *wild-cat*. Cha'hta kóa *panther;* Cr. kóa kátcha *wild-cat*.

séti *persimmon*. Cr. sáta.

súli *buzzard*. Cr. súli.

tá'hsi and átsa *war-club;* Cr. atása. Cf. also: aták *stick* in Mohawk; atá'hsa *cane*, *stick*, *rod* in Cayuga and Oneida. The high post which formerly stood in Atasi village on Tallapoosa river (vol. i. 128) is probably a representation of the *restless* or *leaning pole* occurring in some of the Maskoki migration legends.

tchóyi *poplar*, *trough*, *canoe*. Alibamu, Koassáti, H. tchóye tchóyi; Cr. tchóli *pine-tree*. Cf. Náktche. (Tree names sometimes alter their signification.)

wáhya *gray wolf*. Alibamu and Cr. yáha.

There may be also an old connection between Cher. túksi *terrapin* and Cha'hta lúkshi *turtle;* cf. also pakaní *nut* of Shá-wano (Algónkin family) with pakanúdshi *plum*, lit. "little peach" in Creek.

NAKTCHE-MASKOKI LOAN-WORDS.

The confederacy of the Naktche villages on the Mississippi river, with its narrowly circumscribed territory, contained several villages speaking languages of different families. In 1885 I had the opportunity of becoming acquainted with the Naktche language as formerly spoken by the *ruling class* in that confederacy, and herewith present some of its terms which were either borrowed, or show so close a resemblance as to be easily mistaken for loan-words. Two of them, *rattle* and *to cough*, are perhaps onomatopoetic.

ă'sha *hickory-tree*. Cr. ódshi, Hitch. ódshagi.

ă'dsha, ătch *hog-potato*. Cr. and other M. dialects áhi, áhe.

ínt, íⁿta *tooth*. Cr., H. and Cha'hta núti; Koassáti náti.

mak *here*. Cr. man *there*.

mak'háwish *to speak*. Cr. mákita.

né'hkwa, né'hv, nék'v *grease*, *fat*. Cr. níha; Cha'hta niá.

ohonáktik *to cough*. Cr. ohókita.

óktu·l *eye*. Cr. tú·lua.

púftav *I blow*. Cr. púfkäs.

shakshák'halish *rattle*, subst. Cr. sá-uka. shaúka.

tulúmnaguk and tulúptaguk *to roll*, v. trans. Cr. tulúmita.
tchúl, shúla *pine-tree*, tchú *tree*. Cr. tchóli, tsúli.
úla *snake*, borrowed from Cha'hta úla *noisy*, *rattling*; sínt' óllo *rattlesnake*, Cha'hta.
yánasha *buffalo*. C. yánasa, yenása.

The *Timucua* language of Florida has borrowed several terms from the Maskoki dialects, especially from Seminole-Creek, which was spoken in closest vicinity to it. Among these are ífa *dog*, hú·li (spelt there "hurri") *war*, yatíki *interpreter*, tóla *laurel* or *sweet-bay*; while the word ábu, ápu *stick*, *wood*, *tree* (in Creek and Hitchiti ábi, ápi *stem*, *stick*) was common to both families. The terms híniha and holá'hta were probably borrowed by the Creeks from the Timucua, who obtained their term paracussi *sub-chief*, *village-chief* from the Yuchi: pá·län ku=siä'n "chief very small."

In the *Tonica* language, which I had occasion to study in 1886, some of the shorter terms, like *arrow*, resemble Maskoki words, especially of the Koassáti dialect, but do not rest on true affinity. The grammars of both stocks differ entirely. But the term for *buffalo*, yánasa, is common to Tonica, Naktche, Cheroki and the Maskoki dialects, while Yuchi has: wetiné ka *fat cattle*, from wetiné *cattle*, *cow*.

Comparisons with languages spoken west of the Mississippi river have yielded but few terms which can with safety be regarded as Maskoki loan-words, and this may figure as an additional argument against an immigration of the Maskoki tribes from these parts in more recent times. We may compare, however, the word for *maize*, in Wichita tāsh (tă'dse tāsh *maize stalk*, tatsté-e tāsh *ear of corn*) with the Cha'hta tándshi *maize*. All other Pani dialects differ in this term.

ALPHABETIC INDEX

— OF —

THE TWO VOLUMES.

NOTE. — Proper names derived from Indian languages are pronounced in so many different ways by both Indians and whites, that only one form of spelling them could be received into this Index.

The passages which treat more extensively of a subject are marked by *italic figures*. Sometimes one name occurs two (2) or three (3) times upon the same page.

Names beginning with 'l are placed after *l*, names with initial *tch* and *y* after those with intial *t* and *w*.

ERRATA.

Before studying the *two Texts*, readers should necessarily make the following important corrections with *red* ink, as the present readings are badly disfiguring the sense:

Vol. ii. p. 10, 23: *read* i'lanafaíkit *instead of* i'lanafaí = kit.
10, 24: *read* Atássa *instead of* A tássa.
12, 5: *read* ú'h'lánin *instead of* ú'hlánin.
12, 27: *read* lámh' ihádshi *instead of* lámhihádshi.
14, 32: *erase comma after* ní'li.
16, 2. 3: *read* i'lafulídshin (is *one* word only).
16, 4: *read* i'lasawa'lanátchkatis (is all *one* word).
20, 12: *read* ímmig' apíktchi *instead of* immiga - píktchi.
20, 24: *read* i'liktahúngan u'ládshik.
20, 26: *read* ama'hmówats *instead of* amakmówats.
21, 8: *read* alafáng' úmigat (in *two* words).
21, 30: *read* ma umiɬtchut *instead of* ma-umíɬtchut
22, 28: *read* ák'lik *instead of* ák'lik.
22, 38: *read* hátkakat (in *one* word).
23, 13: *read* pafáksiɬtchût *instead of* pafáktsiɬtchût.
24, 30: *erase* ungá'htchut *as unnecessary*.
25. 23. *erase semicolon after* kádshik.
25, 25: *read* mámiska yámiga *instead of* mámis kayámiga.

The other ADDENDA and CORRIGENDA in the two volumes are as follows:

FIRST VOLUME.

p. 16. The "Nachee" or Notchees were a people on the coast of South Carolina. Language unknown.

41. The Tonica language is independent of any other now known.

44. The Yowáni or Heyowáni were a Cha'hta tribe.

71. Ehawokales is Tchawákli, a former Creek-speaking town on Chatahuchi river.

111. Biloxi Indians. Their language belongs to the Dakotan or Sioux family, as I ascertained in 1886.

114. Houma is the parish seat of Terrebonne Parish, La.

165. *Erase the form* ahopáya.

p. 200. *Read* atchúli *old*, not atchúla.

200. *Read* lástis, laslátis *it is black*.

223. *Read* ika há'lbi, *not* ika hálbi.

237. *Remove pages* 237–251, these being reproduced in a correct form in vol. ii. 8–25. Cf. Note to ii. 73.

SECOND VOLUME.

p. 38. *Read* (cf. Zuñi, p. 35) *and not* (cf. Zuñi, p. 41).

39. *Read* (line second) l. people, p. 29.

48. *Read* (line 5 from below): *and was much longer*.

60, line 6. *Read* ō′·lin *instead of* ‘l(ō′·lin).

68. *Read: and* their importance, not *of* th. i.

70. The sound ‘*l* in Atákapa is not quite certain.

86. *Read* hi‘läídshäs, *not* ki·läídshäs.

94. *Read* i‘ló‘läs *instead of* ‘ló·läs.

129. *Read* (under -usi) hóklusi *girl* and hókti *woman*, not hóktusi and hókta.

153. *Erase* (under isa‘líyalis): du. and pl.

CONTRIBUTIONS FROM THE SHAW SCHOOL OF BOTANY.

No. 3.

Description of Lycoperdon Missouriense.

By William Trelease.

One of the first plants to attract my attention on coming to St. Louis, in the fall of 1885, was a large puff-ball, quite abundant in the arboretum of the Botanic Garden, especially in the shade of low evergreens. The development of a large number of specimens was watched, and as they reached maturity it became evident that they belonged to a form quite different from any of the described species with which I was familiar. In the following autumn, the same species was found in large numbers in the grove just beyond the western terminus of the Papin ave. extension of the Franklin ave. car-line. It has also been observed in Forest Park, and was collected by Mr. Pammel at Old Orchard, Mo.; and since this description was written has been sent me from Concordia, by Rev. C. H. Demetrio. In view of its striking appearance and distinct characters, I have prepared the following description for the Academy. This species, like other large puff-balls, is doubtless edible, but I have not tested its culinary merits.

Lycoperdon Missouriense, n. sp.—Young plants smooth, cylindrical or commonly somewhat constricted at the middle, the summit dilating with age; dull, creamy white, drying into some shade of flesh color, then frequently areolated with paler approximated lines. Mature plants 3 to 4 inches high, 2 to 4 inches in diameter; brown with a slight admixture of purple, somewhat glossy: sterile base soft, cellular, very stout, comprising half or two-thirds of the height of the plant: peridium thin, very fragile, flaking away from the dilated fertile apex, exposing the clear buff sporiferous mass: capillitium attached to the sterile base, somewhat olivaceous when old, much of it persisting through the winter in sheltered places; its threads long, bulbous-septate, remotely branched, the branches forming obtuse angles: twigs 2.5 to 3.8 μ. in diameter, gradually attenuated and somewhat flexuous toward the end, the dilatations at the septa 3.8 to 5 μ. in diameter: spores globose, very thin-walled, smooth, stalkless, yellow, paler than the capillitium, 2.5 to 3.75 μ. in diameter.—In sod, under trees—St. Louis, Old Orchard, and Concordia, Mo.

CONTRIBUTIONS FROM THE SHAW SCHOOL OF BOTANY.

No. 1.

On the Pollination of PHLOMIS TUBEROSA, *L., and the Perforation of Flowers.*

By L. H. PAMMEL.

Last spring my attention was drawn to a rather large and conspicuous cluster of *Phlomis tuberosa* growing in the Botanic Garden The species is a native of Europe and has become sparingly naturalized in the United States. The pollination of this species seems not to have been studied, although we have an admirable account of the pollination of *Phlomis Russeliana* by Loew. Our species, although agreeing in some important particnlars with the Syrian, differs in color and some other minor points.

The structure of the flower clusters is that common to many of the Labiates, in that the flowers are borne in cymose axillary clusters; but in this case the clusters are very dense, so that the flowers are not separated readily. The tubular calyx is 10-ribbed, and terminates rather abruptly in 5 awns.

A plant when in flower is very conspicuous not only from the purple color of the corollas, but also from the number of flowers open at the same time, as there are often as many as six or eight in one cyme; and on going to the flower at any time of the day, one could see several species of *Bombus* and a *Xylocopa* collecting nectar, besides other small Hymenoptera which principally collected pollen. The corolla is decidedly two-lipped. The upper lip arches over the lower, and is slightly notched. At the time of pollination the upper lip lies close to the lower, so that a humble-bee on entering the flower must force the former back, when its thorax is dusted with pollen from the anther cells which lie among the rather numerous hairs in the arched upper lip. This lip readily returns to its former position on account of the elastically-hinged arrangement to be found on its posterior part close to the tube of the corolla. This arrangement is also described by Loew (61 *a*, 62) as occurring in *Phlomis Russeliana*, and has been called by him "Charnier Gelank." MacLeod (68) finds a similar arrangement in *Scutellaria alpina*, which he says agrees in this respect with *Phlomis Russeliana*. In making a comparative study of several species of *Scutellaria*, he finds that this arrangement is most highly perfected in *S. alpina*, while *S. galericulata* is intermediate between *S. alpina* and *S. minor*. The elastically-hinged arrangement in *Phlomis tuberosa* is as follows: — That portion of the tube of the corolla which connects it with the upper lip is slightly inflated as shown in Figs. 1 and 2, while above this in the upper lip, on each side, at its farther end, is a small groove running to a point, and above this swollen portion on the tube of the corolla immediately back of these grooves there is a well pronounced keel. This keel enables the upper lip to be moved back at an agle of 45°. The lip remains in this position till the insect leaves the flower, when it again returns to its former place. By this arrangement the flower is protected from unbidden guests, as only such insects are able to get at the nectar as can push the upper lip back. The four stamens are arranged in two sets, and are somewhat shorter than the two-lobed style. The anther cells face the lower lip. The filaments of the shorter pair are attached somewhat above the longer pair on the tube of the corolla, well up to the throat (Fig. 5). The longer pair, attached somewhat lower down on the tube of the corolla, lie above the style (Figs. 1, 2, 3 & 5), and extend somewhat farther out than the lower pair, but the filaments of this longer pair differ from those of the short stamens in having a peculiar arrangement to hold the style in position (Fig. 5 *a′*). These filaments end in a pair of awl-shaped appendages that rest against the opposite side of the tube of the corolla, and form a little arch over the style. Experimentally their action can be demonstrated by cutting a flower open with a pair of scissors and applying a needle to the style. The style has free movement in the arch, and when moved, as it must be when the insect enters the flower to get nectar, it easily returns to its position over these appendages. According to Loew (61 *b*) the appendages in *Ph. Russeliana* are for the purpose of holding the stamens in position, and he thinks that the hairs in the upper lip also serve the same purpose.

Insects, attracted by the clusters of bright purple flowers, find a landing-place on the lower lip of the corolla, and experience no trouble in finding the nectar, as there is a well marked groove in the middle and larger lobe of this lip, which diminishes in size downward till the nectary is reached, where it disappears. In addition to this groove there are some nectar marks: two on the middle lobe (one on each side of the groove), and one on each of the lateral lobes. These nectar marks are colored somewhat deeper than the rest of the corolla, and run to the groove, where they disappear.

There is an abundance of nectar, secreted from the well developed nectar-gland situated immediately underneath the pistil, in the form of a fleshy outgrowth arising from the receptacle. This gland is usually somewhat angled, sending up one lobe between each of the lobes of the ovary (Fig. 8 *gl*). The nectary occupies the lower part of the tube of the corolla and measures 5 mm. in length. Its base is 1.5 mm. wide. The tube of the corolla is 10 mm. long, and at its throat is 2.7 mm. in width. The tube of the corolla is considerably enlarged above the nectary (Fig. 4 *g*); this enlargement is not peculiar to this plant, but is also to be found in *Lamium album*, *Leonurus Cardiaca*, and others. There is developed at this enlargement a ring of rather stiff hairs, which excludes small insects. The occurrence of a ring of hairs above the nectary is also common to other Labiates, such as *Ballota nigra*, *Stachys sylvatica*, *Hormium pyrenaicum*, *Brunella grandiflora*, etc. It is also present in species belonging to widely separated orders, e.g. *Cobæa scandens*, *Bryonia alba*, *Pedicularis sps.*, *Echium*, *Bouvardia*, etc.

As regards dichogamy, the species seems to be slightly proterandrous, the stamens being mature when the upper lip lies close to the lower, and the style usually lengthening somewhat after this period. There is indeed considerable variation in this respect. *Ph. Russeliana*, according to Loew (61 *c*), is without any apparent dichogamy, at least so far as he was able to observe. *Lamium album* and *amplexicaule*, and *Salvia gesneriæfolia* (115 *a*.), are also without any pronounced dichogamy. On the other hand, *Stachys sylvatica* (82 *a*), *Salvia splendens* (113 *a*), *S. pratensis* (82 *b*), and *S. officinalis* (82 *c*, 96), are proterandrous. In some cases where there is strongly marked proterandry, there arise as a result gyno-diœcious species, some flowers of which are small and with partially or entirely abortive stamens. In such cases cross-pollination must result unless, as is sometimes the case, short-tongued insects visit only the small-flowered forms, which of course cannot lead to cross-pollination. The genus *Calamintha* is interesting in this respect. *C. Clinopodium* (82 *d*) is variable as regards its gyno-diœcious character, and therefore presents all stages. The American *Calamintha Nepeta* (110) is proterandrous. *Mentha arvensis* (82 *e.*), *Thymus serpyllum* (82 *f.*, 26), and other species belonging to these genera, are typically gyro-diœcious: so that, in this regard, Labiates are variable.

The flowers of *Phlomis tuberosa* are adapted to pollination by humble-bees, as has been shown, by the elastically hinged arrangement in the upper lip and the length of the tube of the corolla. Several of our species of *Bombus* must be able to do efficient work in their cross-pollination, as the measurements of their tongues indicate. Mr. Robertson, who has kindly identified the insects I sent him, gives me the following measurements: The tongue of a female of *Bombus separatus* measured 11 mm., while that of *B. Pennsylvanicus* was 16 mm. long. I frequently saw a large species of *Bombus*, probably *B. Pennsylvanicus*, which entered the flowers in a normal way, and most of the flowers were pollinated by this insect. Besides this there was one other humble-bee, a worker of *B. vagans*(?), which visited the flowers, but mostly those which had previously been used by *B. Pennsylvanicus*. The tongue of this insect measured 6.5 mm., so that it was hardly long enough to reach the nectar, and I doubt whether the insect is strong enough to push the upper lip back as it regularly visited the older flowers, no doubt it may be of service to the plant. *Anthophora* and *Melissodes*, which have longer tongues than those of *Bombus Pennsylvanicus*, are frequent visitors to flowers with deep seated nectar, but they were not noticed on *Phlomis*; on the other hand, *Xylocopa Virginica* made perforations and used them exclusively. I shall, however, call attention to this in another part of the paper.

The two species of *Phlomis* are much alike in the awn-pointed lobes of the calyx, the hinged arrangement in the upper lip, and the compactness of the flower-cluster. The flowers of *Ph. Russeliana* are somewhat larger, and are therefore adapted only to long-tongued insects, since the tube of the corolla is 20–22 mm. long. But the tube of *Ph. tuberosa* is only 10 mm. long, so that it is adapted to a much larger range of insects. Accordingly

Loew (61 *d*) found *Ph. Russeliana* visited in the Berlin Botanic Garden only by *Bombus hortorum*, and he says that *Anthophora pilipes* is the only other insect in North Germany which can do adequate service in its pollination.

In both of these species there is a beautiful contrivance for securing cross-pollination. But while the Syrian, according to Loew, is proof against such depredators as *Bombus terrestris,* which perforates many European flowers in order to get at their nectar, *Ph. tuberosa* is not proof against these unwelcomed visitors. Notwithstanding that *Xylocopa* has a tongue of 7.5 mm. and can therefore get at a portion of the nectar in a normal way, it chooses rather to perforate the flowers, the awn-pointed calyx lobes offering no resistance.

But I think the most striking difference between the species is in color, and as this is such an interesting biological fact I will summarize what Hermann Müller says about it in his classical work "Die Befruchtung der Alpenblumen" (90 *a*) :

Not only have Hymenoptera been most active in the development of such peculiar contrivances as the bell-shaped corollas of Convallarias, Campanulas, and Gentians; the funnel shaped corollas of Rhododendrons and Echiums; the tubular corollas of Loniceras; the closed corollas of Linarias and Antirrhinums ; the spurred flowers of Aquilegias and Aconitums; the labiate flowers of Lamiums, Salvias, Melampyrum, and Pedicularis; the inverted flowers with small openings of Arctostaphylos and Vaccinium; and the papilionaceous flowers of Trifolium and Robinia;—but they have also influenced the colors of flowers in a most marked degree. Flowers adapted to a large range of insects, like those of *Compositæ*, *Saxifrageæ*, *Valerianaceæ*, *Potentilla*, and *Ranunculus*, are usually yellow or white. But in such highly modified flowers as Lamiums, Salvias, Delphiniums, Aconitums, and Aquilegias, the colors are generally violet, blue, pink, or purple. In these and other genera a change seems to have stepped in, especially where flowsrs have the same structure and are pollinated by the same class of insects.

Our species of *Monarda* show this color-range beautifully. *M. didyma** is bright red, *M. fistulosa* is rose color varying to white, *M. Bradburiana* is pale purplish-white, *M. punctata* is yellowish. *Dicentra Canadensis* is white, *D. eximia* purple. *Viola striata* is white, *V. pubescens yellow*, *V. palmata* var. *cucullata* blue. Of European examples, *Aconitum lycoctonum* is yellow, *A. Napellus* blue ;

* This species is adapted to Lepidoptera for pollination.

Pedicularis tuberosa is yellowish-white, *P. chamædrys* purple. In Labiates the prevailing colors are blue, rose, lilac, and purple; seldom yellow or white. *Lamium album, however*, is white, while *L. maculatum* is red. *Phlomis tuberosa* is purple, *Ph. Russeliana* is yellow. *Salvia glutinosa* is yellow, *S. pratensis* blue. Why should we have changes in color of such closely related species?

Hermann Müller has shown that bees confine themselves in a given visit to a given species. Now, much time would be consumed in distinguishing between such closely related species as *Lamium album* and *L. maculatum*. Müller has shown that insects, even *Hymenoptera*, which have developed a high color-sense, do not always distinguish between such flowers as *Ranunculus acris, R. bulbosus,* and *R. repens;* and they even fly from these to *Potentilla verna* and *P. alpestris.* This also occurs in some genera where the nectar is seated somewhat deeper, as in *Mentha sempervivum, Androsace,* and *Compositæ.* Slight changes in color must therefore be of great use to an insect, just as changes in color of parts of a flower after pollination are of use to the insect by indicating that its services are no longer needed. Müller believes that the changes in color, in closely allied species, have been produced for reasons of this kind.

PERFORATION OF FLOWERS.

The perforation of flowers by insects, and in a few cases by birds, to get at the nectar by fraudulent means, is a matter of common observation; but in a few cases this is the normal way of procedure, as has been shown by Darwin (24) and Müller (91 I. *a*, 81 *a*, 82 *b'*), for insects are obliged to perforate the lax inner membrane of some orchids (nearly all of the British Ophreæ according to Darwin) in order to get the nectar which lies within their tissues; and in the case of *Laburnum*. etc., Müller has shown that insects puncture the thickened bases of the standard petal in order to get nectar.* I ought also to call attention to the destructive work of species of *Megachile*, which cut out parts of

* That Lepidoptera should be capable of doing this is not strange, since in Queensland and Australia a moth (*Ophideres fullonica*) bores through the thick rind of an orange (Darwin, Fert. of Orchids, p. 40; see also a valuable paper on this subject by Breitenbach in Jenasche Zeitschrift, 1882, p. 157-214, Pl. iv.-vi.)

the petals of Roses, Pelargoniums, etc., and use them to line their nests. I was led to treat this subject when I saw the notes of Dr. Schneck and Mr. Van Ingen in the "Botanical Gazette," and about the same time noticed that the flowers of *Phlomis*, *Symphytum*, and *Monarda*, are regularly perforated in the Botanic Garden.

A century ago, Sprengel noticed that flowers were perforated. Since his time many European as well as American observers have noticed perforations. Among them I may mention Darwin, Delpino, Ogle, Kerner, Loew, and Hermann Müller. To Loew and especially Müller are we greatly indebted for painstaking labor in giving lists of flowers and their visitors, and, with the exception of these and a few by other investigators, we have no statistical tables on the pollination of flowers and their insect visitors, so that we have little accurate information as to what insects perforate flowers. It is of value to know not only that a given flower is perforated, but also what relation the insect bears to the flower which it perforates. It is, indeed, interesting to follow out these relations from Müller's tables. But much that has been written on the subject is to be found in the way of short notes in various journals. I have attempted to bring together some of these observations, but it has been somewhat difficult to get hold of full files of some periodicals, so that the bibliography and examples are not as complete as I should wish them to be. In this connection I must express my indebtedness to Professor Trelease, who has kindly placed at my disposal the available literature on the subject, and especially his slip-index and collection of pamphlets.

Darwin (25 *a*) in his "Cross and Self-fertilization," etc., states that out of many hundred specimens of Red Clover examined by him nearly all were perforated, and he has even seen whole fields in the same condition. Thos. Belt (11) and others have noticed the same thing. It is quite as common for Red Clover to be perforated in this country as it is in Europe. The fact that *Symphytum officinale*, *Linaria vulgaris* and *Scrophularia nodosa* are perforated was known to Sprergel (106). In this country large numbers of flowers of certain species are perforated, as Leggett (58), Merriaam (79), Stone (107), Bailey (7) and Trelease (113) have shown to be the case in *Dicentra cucullaria*, *D. Canadensis*, and *D. eximia,* both cultivated and in the wild state. *Corydalis aurea* and *C. glauca* are found in a similar condition, and Prof. Trelease (112) has found large numbers of the flowers of *Impatiens fulva* perforated, while W. E. Stone (107) states that almost every individual of *Gerardia integrifolia* which he had occasion to examine was perforated by some insect. Prof. W. W. Bailey (3 & 4) also finds *G. pedicularia* similarly injured.

In the summer of 1883, in the vicinity of La Crosse, Wis., I noticed large numbers of honey-bees on the flowers of Red Clover, and wondered whether they made perforations, or what they were doing. In some cases they obtained pollen, but in a vast majority of cases nectar was collected through perforations made by some other insect. Among bee-keepers there is a notion that the Italian bee is able to get nectar from Red Clover. I doubt whether this is true, for in my experience I never found them collecting nectar in the normal way; they seemed to collect only through perforations made by some other insect. One thing will show, in part at least, why honey-bees go to the Red Clover at certain times and not on other occasions. It is a well known fact that the amount of nectar secreted by a plant varies according to season and locality. There are periods, as I have had occasion repeatedly to observe, when hive-bees cannot collect enough to supply their young, and they then freely use the perforations made by *Bombus* and other insects; but when there is an abundance of nectar they pass over fields of Red Clover, and when *Monarda punctata* is in flower, and has a good supply of nectar, they will even pass over fields of White Clover and fly some distance to fields of wild Bergamot.

Although the rule seems to be that honey-bees do not perforate flowers, there seem to be exceptions, for no less an authority than Hermann Müller states that they perforate the flowers of *Erica tetralix* (82 *d'*), using their mandibles to bite holes in the tube of the corolla. The tongue of the honey-bee is only 6 mm. long, so that it is not able to get the nectar otherwise in these early flowers. Later he found honey-bees collecting nectar in the normal way, but he failed to observe whether these late flowers were smaller or not. He has recorded one other case, that of *Nepeta Glechoma* (82 *c'*), where *Apis* perforates the tube of the corolla in order to get nectar. On the 17th of May, 1873, he found a single specimen of *Apis* continually trying new flowers of *Nepeta Glechoma* (89 *a*) till one was found where *Bombus terrestris* had perforated the flower. It is not always an easy matter to tell whether an insect makes the perforations, especially when these are in the form of longitudinal slits, or whether it is merely looking for the perforations of some other insect. In flowers where the tissue is firm, these slits close over quite effectively, and, as I have convinced myself in the case of *Symphytum* and *Phlomis,* are not readily seen. While the honey-bee makes at most few perforations, Müller records many cases in which it uses perforations made by other insects: but it is sufficient here to refer to his works for these.

In this country, Meehan believes that *Apis* perforates the flowers of *Salvia splendens.* Delpino, Comes, and a few other observers, also state that the honey-bee perforates corollas. I think, however, that generally honey-bees only use the perforations made by other insects, and they are certainly quick to perceive these perforations. Müller records the most interesting case of *Salvia Sclarea* (92), in which the tube of the corolla is so long that the honey-bee is not able to get the nectar in a normal way. It made several attempts, but did not try to perforate the corollas. When, finally, it found several in which the corollas had just loosened, it immediately began to sip the little drops of nectar which still remained attached to the base of the corolla. It is certainly a clear case, for the insect tried in every way to get nectar, except by perforating the corolla.*

From observations thus far published, *Bombus* is the most frequent perforator of flowers. In Germany, *Bombus hortorum*, *B. senilis*, and *B. fragans* never perforate flowers. Their tongues measure respectively: worker, 18–19 mm., 11–15 mm., 15 mm. They pollinate such flowers as *Dicentra spectabilis.* Some of the species which perforate flowers, and the length of their

* In this connection it is interesting to refer to Prof. Riley's Entomological Report to U. S. Department of Agriculture, 1885, p. 333. Under his direction Mr. N. W. McLain made some careful experiments to determine whether, as has been claimed, honey-bees puncture grapes and other fruits in order to get sugar, but found that even when brought to the test of hunger they made no attempts to grasp the cuticle of the berries with their mandibles or claws. When the grapes burst from over-ripeness, or whenever the exterior part was exposed, they eagerly sucked the juices, yet they did not even then penetrate the delicate film surrounding the pulp.

tongues, follow: *Bombus muscorum,* tongue of female 13–15 mm., male 12–13 mm., worker 9–10 mm. *Melampyrum nemorosum,* tube of corolla 18–20 mm. *Bombus Rajellus,* tongue of female 13–14 mm., male 10–11 mm., worker 11–13 mm. The nectariferous spur of *Dicentra spectabilis* is 18–20 mm. long. *Bombus lapidarius,* tongue of female 12–14 mm., male 8–10 mm., worker 10–12 mm. Three flowers are perforated by it: *Symphytum officinale,* corolla 14 mm. long; *Melampyrum pratense,* 14–15 mm. long; *M. nemorosum,* 18–20 mm. long. Seven flowers are perforated by *Bombus pratorum. Dicentra spectabilis, Melampyrum nemorosum, M. pratense,* and *Rhinanthus major;* in the latter the tube of the corolla is 10–11 mm. long. The tongue of a female was 12–14.5 mm. long, male 8–10 mm., worker 8–12 mm. In *Symphytum officinale* and *Trifolium pratense,* the tube of the corolla is 9–10 mm. long.

The tongue of a female of *Bombus terrestris* was 9–11 mm. long, and of a worker 8–9 mm. In the Alps it visits 85 species; 54 are strictly alpine. Ten different species are perforated; 6 of this number are strictly alpine. Müller, in his "Befruchtung der Blumen," records its visits to 79 species; out of these, 17 are perforated. It perforates such flowers as *Aquilegia vulgaris,* where the nectariferous spur is 15–22 mm. long. In *Pedicularis sylvatica* the nectariferous tube is 10–14 mm. long; *Galeobdolon luteum* 8 mm. long; *Galeopsis Tetrahit* 11–17 mm. long; *Nepeta Glechoma,* in small-flowered form 6.5–8 mm. long, in large-flowered form 14–16 mm. long. While this species perforates a great many flowers, *Bombus mastrucatus* opens those of no less than 34 different species out of 76 which it visits; 36 of these are strictly alpine. The tongue of a female measured 10–12.5 mm., of a worker 9–10 mm. So intent is this insect on its malicious work that it perforates many flowers where the nectar is easily accessible, as in *Anthyllis vulneraria* in which the tube of the corolla is 9–10 mm. long; *Trifolium pratense* and its var. *niva e* 9–10 mm. In *Salvia pratensis* it is hardly 8 mm. long; in *Vicia cracca* 5–6 mm. long. From the above is seen that *Bombus mastrucatus, B. terrestris, B. pratorum,* to which must be added *Xylocopa violacea,* are the principal perforators of European flowers. The second is one of the commonest of European humble-bees. The first is found principally in the Alps, but also occurring in Middle Europe; the last is an inhabitant of the southern and warmer regions of Europe.

The examples of flowers perforated by *Bombus terrestris* show that it mainly pierces those from which it cannot get nectar in a normal way. Müller (87 *a*) has found this interesting difference between its visits to flowers on the plains and valleys and to those of alpine and sub-alpine regions; that while in the lower regions it perforates many flowers where the nectar is in part accessible to it, e.g. *Vicia cracca* and *Salvia pratensis*, on the other hand *Linaria alpina*, *Pedicularis asplenifolia*, *P. tuberosa* and *Trifolium pallescens* are visited in a normal way in alpine regions. Müller also found a constant difference in the length of its tongue. In the Alps its tongue was usually 8–11 mm. long, while in the lowlands only 7–9 mm. long. *Bombus terrestris* is one of the most abundant of European humble-bees, and this is perhaps one reason why it uses these illegal means to get nectar. But *B. mastrucatus*, as Müller's (87) investigation shows, is the worst enemy to alpine flowers. Notwithstanding that its tongue is of sufficient length to enable it to reach the nectar of such flowers as *Pedicularis tuberosa*, *Vicia cracca*, and *Linaria alpina*, it perforates them, and only pollinates such flowers as *Taraxacum*, *Leontodon*, *Carduus*, *Epilobium*, and others of this class, which it could not well perforate unless it were to go to more trouble than getting the nectar in a normal way involves.

Müller has designated this as a case of dystelology,* as the mutual relations which exist between flowers and insects are destroyed and floral contrivances rendered inoperative by the actions of this bee. Loew (63 *a*) would call it rather a case of disharmony, since there is developed in *Bombus mastrucatus* a morphological character (the small teeth on the mandibles), useful in the perforation of corollas. By disharmony he understands the non-adaptation of certain insects to certain flowers; for which reason he thinks that some German species of *Bombus* perforate such flowers as *Lathyrus latifolius* and *Monarda didyma*. This non-

* For a discussion of the modern view of teleology see Haeckel's "Generale Morphologie der Organismen," "History of Creation," and "Evolution of Man"; also Dr. Asa Gray's review of Darwin's "Fert. of Orchids," Am. Jour. of Sci. & Arts, ser. ii. vol. xxxvi. p. 33. In Darwiniana, "Charles Darwin: A Sketch," p. 283; "Evolutionary Teleology," p. 356; Delpino, and others.

adaptation or disharmony must develop among flowers and insects of a given region whenever some plants begin to develop tubular flowers which surpass in length the tongues of their former visitors. In other words, perforations are made by short-tongued humble-bees and *Apis*, in consequence of the lengthening of the tubes of certain bee-flowers beyond the mean length of the tongues of these insects. For this reason few of the native plants of Germany have nectaries over 17–20 mm. long. If they had, these flowers, being more frequently perforated, would stand less chance of being pollinated than now, and the species might in some cases even become extinct.

The Carpenter Bees, belonging to the Genus *Xylocopa*,* do considerable injury to flowers in more southern latitudes, where they abound. Delpino, Comes, and others. find that *Xylocopa violacea,* a native of Southern Europe, perforates many flowers, such as *Antirrhinum majus, Linaria vulgaris,* and *Mirabilis Jalapa. Xylocopa Virginica,* according to Cresson,† is found in the middle, southern, and western States, and of the 27 species of this genus mentioned in his catalogue this is the most northern and has the widest distribution. The species no doubt causes considerable annoyance, as Mann, Ryder, and Miss Murtdfeldt have shown. Mr. Mann was the first to describe one method which it uses to perforate flowers, in which "the insect applies its sharp and wedge-shaped maxillæ to the grooved surface of the tube and splits this open 3 or 4 mm. from the base." Dr. Schneck and Mr. Van Ingen each record several cases—*Physostegia, Mertensia,* and *Petunia*—in which the tube of the corolla had longitudinal slits, but as perforators they found humble-bees (*Bombus?*). As these slits correspond so well to the slits I found on the tube of the corolla of *Phlomis,* I bring them up in this connection. I frequently found this *Xylocopa* in the act of making longitudinal slits in the tube of the corolla of *Phlomis tuberosa*. The insect applies its powerful mandibles against the tube of the corolla until it gains entrance, then, thrusting its maxillæ in as far as it can

* *Xylocopa* differ from *Bombus* in that the mouth-parts are adapted to boring as well as sucking. They are capable of boring a foot or more into pine and even hard wood, and in constructing their nests show considerable architectural skill.

† "Catalogue of N. Am. *Apidæ*, with Description of New Species," from Trans. of the Am. Entomological Society, vol. vii.

in a longitudinal direction, the tissue yields easily, so that longitudinal slits are the result. At other times the mandibles are drawn backward and forward, thus causing longitudinal slits. The number of slits varied from one to three. The insect did not take much trouble to find the old slits, but went directly at making new ones, as it seemed to be easier for it to do this than to waste time in looking for the old ones.

Wasps also perforate flowers, especially such as are adapted to this class of insects. Prof. Trelease found that the flowers of *Scrophularia nodosa*, var. *Marylandica* (114) are perforated by the White-faced Hornet, *Vespa maculata;* he also found that *Ribes Cynosbati* (113) is perforated by the same species. Müller (82 *a'*) found a species of *Odynerus* perforating the flowers of *Symphoricarpus racemosus,* which Prof. Trelease (113 & 114) has also found perforated in this country. Mr. Robertson has reported to me several interesting cases where wasps use perforations, and, at least in one instance, make them. At Orlando, Fla., he found five species of wasps belonging to the genera *Polistes*, *Eumenes*, and *Odynerus*, which sucked the flowers of *Gaylussacia dumosa*, var. *hirtella*,* through perforations (Fig. 6 *a*, Pl. vii.), which are at first very small, but finally large and irregular. At Clinton, Mo., he observed that *Odynerus foraminatus* made perforations in the tube of the corolla of *Monarda Bradburiana*,† which, as he thinks, were made by the wasp taking the tube between her jaws and cutting towards the mouth of the corolla, thus loosening a triangular piece which could be closed over the opening (Fig. 9 *a*, Plate VII.) In the Botanic Garden I frequently found the flowers of this species perforated, but the perforations were in the form of longitudinal slits.

While wasps do not generally perforate flowers, they are not above using those perforated by species of *Bombus* and other insects; for these, in their rapid visits to flowers, are certain to leave some nectar. Insects much lower in the scale than wasps frequently use the perforations made by species of *Bombus*, as

* I have found flowers of *Vaccinium corymbosum* perforated at Newton, Mass., but did not see the insects which made the perforations.

† The flowers are adapted to long-tongued insects, and, as Mr. Robertson informs me, are regulerly visited by *Bombus Pennsylvanicus* ♀ and a species of *Bombylius*.

Müller (91 ii. *a*) has shown to be the case in a small Ichneumon Fly which eagerly sought the nectar left in the flowers of *Convallaria Polygonatum* by *Bombus mastrucatus.*

Ants are especially fond of saccharine matter, and are frequent visitors to flowers, but only for nectar. Their visits are entirely injurious to the plant. They frequently gnaw parts of the flowers and make irregular holes, thus gaining an entrance, or they use the perforations made by other insects.

Beetles, although not high in the scale of development, and certainly low as far as the adaptation to flowers and their pollination is concerned, show, in a few cases, some ingenuity in getting at nectar, as Müller (91 i.) found to be the case with *Cetonia aurata*, which feeds on delicate parts of various flowers, is especially fond of nectar, and was found on the flowers of *Convallaria Polygonatum* eating its way from the top of the perianth to where the nectar is found at the base of the pistil, where it began to feed on the nectar-secreting gland until the wall of the ovary was reached, when it left the flower.

The acute observer Sprengel found that large numbers of the flowers of *Symphytum officinale* were perforated by one of the flower-beetles, and that ants used these perforations. Mr. B. M. Vaughan, who found the flowers of *Corydalis aurea* perforated at Madison, Wis., is of the opinion that these perforations were made by one of the flower-beetles.

It is not strange that birds should at times perforate flowers, since so many flowers are well adapted to pollination by them. Prof. Trelease (113) mentions that, according to Prof. W. A. Henry, the humming-bird *Trochilus colubris* probably perforated the flowers of *Tecoma radicans.* Dr. Schneck (103) and George Sprang (105) have found these perforated, but the latter found ants gnawing through the corolla. In the Botanic Garden there was hardly a single fully opened flower of this species which did not have a few slits. Prof. Beal reports that Mr. Hollingsworth (50) found the flowers of *Fuchsia* pierced through at the base of the calyx-tube and robbed of their nectar. Mr. Robertson writes me that he has seen the humming-bird force its bill into a flower-bud of *Lonicera sempervirens* so that the lobes of the corolla had not been separated, but merely cut through.* Prof. Beal (9) watched carefully for two seasons the flowers of the Missouri Currant (*Ribes aureum*), seeing large numbers of bees collecting nectar from holes made in the calyx-tube ; yet, after careful examination, has never seen honey-bees make these holes, but several times noticed the Baltimore Oriole passing over the bushes and giving each of the fresh flowers a prick with the tip of his beak. No other bird having been seen doing this, he concluded that it is the work of the Baltimore Oriole, while the honey-bee takes the gleanings after the Oriole.

I have alluded to the manner in which *Xylocopa* makes perforations ; I must also describe how this is done by *Bombus* and *Apis*. The mouth-parts† are somewhat complex : the mandibles or upper jaws are developed for the purpose of biting ; the maxillæ and labium are brought into use when the bee takes a liquid into its pharynx. The maxillæ are situated on each side of the labium, and consist of a flattened stipe at the base, then the rudimentary maxillary palpi, and from the stipe projects the triangular and deeply grooved lacinia. When the maxillæ are brought close together a tube is formed which opens into the pharynx. The labium or lower lip consists of a central portion and two pairs of appendages, the paraglossæ and labial palpi. The central portion of the labium is divided into a basal portion, the mentum and a terminal portion, the ligula. "The mentum is hinged to the submentum, which in turn is hinged to the maxillæ by two chitinous rods." The labial palpi are deeply grooved, and when brought together form a tube. In flying from flower to flower the insect carries its sucking apparatus stretched forward so that it is enabled to put it directly into the flower. The mouth-parts

* The opening of flower-buds by insects has frequently been observed. Dr. Ogle found that insects frequently go to the flower-buds of *Pedicularis sylvatica* and thrust their maxillæ in between the folds of the corolla so that they can get at the nectar. Mr. Weed observed the same thing in *Pedicularis Canadensis* (119). Prof. Trelease tells me he has noticed this in several species. Thomas Belt (11) found that the flower-buds of *Phaseolus multiflorus* were perforated, and Hermann Müller (82 c') found the flower-buds of *Aquilegia vulgaris* treated in a like manner.

† For description of structure of mouth-parts of *Bombus* see Hermann Müller's Befruchtung der Blumen, etc., p. 40, No. 87 I. of Bibliography, p. 29. Lubbock, British Wild Flowers, etc., p. 13. A valuable paper by Prof. A. J. Cook, "The Tongue of the Honey-Bee," Am. Bee Journal, vol. xv. p. 490; Am. Naturalist, vol. xiv. p. 271; and Manual of the Apiary, p. 90. In this connection it will not be necessary to refer to the many other excellent monographs on the subject.

of the bee are held in a similar way when the tender cellular tissue is pierced with the tips of its maxillæ. While many humblebees are addicted to boring the tubes of corollas, they also resort to biting the tissues of the flowers by the aid of their mandibles.

The opinion is current that perforated flowers are not as productive as unperforated ones. Delpino has shown, in the case of *Symphytum tuberosum* and *Polygala Chamæbuxus*, that the perforated flowers are absolutely sterile. Ogle (98) states that many flowers of *Phaseolus multiflorus* fail to produce seed because of perforations.

I doubt whether there are many flowers in which one can find more perforations than in *Symphytum officinale*.* In stocks which have several thousand flowers, hardly one can be found which is not perforated. Several stocks in the Botanic Garden gave me ample opportunity of seeing the results from perforated flowers. I did not undertake to count the ripened fruits, but the greater number of flowers developed some nutlets. At this time I had not seen Loew's (63 *b*) experiments on this plant. His results are so striking and conclusive that I give them somewhat in detail. On the 11th of June, 1885, he took several branches which had passed anthesis. On these he had 73 flowers, and was careful to remove later flowers; on the 4th of August 46 flowers were dry, while the remaining 27 flowers had matured 41 nutlets, so that 37 per cent. of the flowers were more or less fertile.

The full fertility of many plants, as Darwin has shown, depends largely on cross-pollination. Insects do not commonly visit flowers unless they get nectar or pollen in return, so that, when a flower is constantly robbed, the regular pollinators do not receive their due share of nectar or pollen, their visits are fewer, and consequently there is less chance for cross-pollination. If the plant is capable of self-pollination seeds may be developed, and often in great abundance, yet Darwin has shown that the progeny of self-fertilized flowers is less vigorous than from cross-fertilized flowers. If the structure of a flower is such that self-fertilization is prevented, and insects do not go to it in the regular way, sterility may result. But in most of the flowers perforated there is an abundance of nectar, and insects which perforate flowers are very

* *Xylocopa Virginica* was frequently seen using longitudinal slits in the tube of the corolla, but I did not succeed in seeing it make the perforations.

hasty in their visits, and therefore always leave some nectar, as can be seen in many cases where the perforator first robs the flowers, after which numerous other insects use the perforations to get nectar, while others again visit the flowers in a normal way. On the whole, I am inclined to think that sterility results more from the disharmonic action of perforating insects than is usually supposed.

The number of individual flowers perforated by *Bombus mastrucatus* (87 *b*) is somewhat startling even in such species as *Vicia cracca* (87 *b*, 90), which it could pollinate with perfect ease, yet nine-tenths of all the flowers were perforated. On the 10th of June, out of 50 flowers of *Gentiana acaulis* (90 *b*) 45 were perforated. Six days later, out of 100 flowers 19 were not perforated; 9 with one, 23 with two, 18 with three, 10 with four, 21 with five openings, so that there were 254 perforations in 100 flowers. Of 50 flowers of *Gentiana verna* (90 *c*), 38 were perforated.

Müller believes that the work of this insect has caused certain species to become extinct or at least diminished in numbers.

In England Dr. Wm. Ogle (97 *a*) found that out of 100 flowers of *Melampyrum pratense* 96 were perforated. Many observers have noticed that in *Trifolium, Erica, Pentstemon,* and other species, the perforations are quite as numerous.

Insects certainly show considerable intelligence in making perforations, or using those made by other insects. One of the most remarkable cases is that observed by Francis Darwin (28) in a cultivated variety of the Everlasting Pea (*Lathyrus sylvestris*), where the nectar is enclosed within a tube formed by the united stamens, at the base of which are two natural openings, one on each side, the left being a little the larger. Humble-bees which bit holes through the standard petal always operated on the left-hand side, so as to reach the larger passage.

The 5 sepals of *Aconitum lycoctonum* are petal-like and irregular, with the upper one hooded or helmet-shaped: two petals (the other three being rudimentary or absent) consist of small spur-shaped bodies raised on long claws, and are concealed under this helmet. Aurivillius (2) has found that in Sweden there are two forms of this flower, in one of which the spur is much shorter than in the other (Pl. VII., Fig. 4). *Bombus terrestris* goes to these short-spurred flowers in a normal way, but it regularly perforates the flowers of the long-spurred form. Now and then perforations were found on both sides, or they were found on whichever side was most convenient for the insect to get the nectar from. When it finds the first long-spurred flower it makes several attempts to get nectar from the throat, but, unsuccessful, bites a hole into the corolla, after which it no longer hesitates about perforating other long-spurred flowers.

Müller (90 *d*–91 *a*, iii. *a*) records an interesting case where a female of *Bombus mastrucatus* obtained nectar from the flowers of *Gentiana verna*, which is adapted to *Lepidoptera*, through perforations made in the tube of the corolla. From this plant it flew to *Gentiana acaulis*, which is adapted to humble-bees; but, so intent was this insect on robbing, that it did not seem to notice that it had gone to a different species, for it began to use the perforations as in *G. verna* (made most probably by some other *B. mastrucatus*). On flying to a third flower of *Gentiana acaulis*, which was not perforated, it noticed the bell-shaped corollas which bees of this species had been accustomed to use for so many ages in species of *Campanula* and the like. Here it entered the flower and made several attempts to get nectar, but without success, came out and flew around for a few seconds, and, as Müller expresses it, examined the flower, then entered the corolla once more and collected pollen, but soon came out and crawled down the side, where it made some perforations in order to get the nectar. This operation was repeated on several flowers; but after this, having learned how to get at the nectar, it did so in a regular and methodic way, first collecting the available pollen.

Müller (91 iii. *b*) records another interesting case where a female of *Bombus terrestris* entered a flower of *Vicia faba* in the normal way. Being unable to get the nectar, the insect forced its head under the banner and stretched its tongue as much as possible, but, being still unable to reach the nectar, it withdrew its head from the flower, and after cleaning its tongue with its forelegs flew to another flower, where the same performances were repeated; but in the fourth she bit a hole in the corolla above the calyx. The same behavior was noticed on the flowers of *Primula elatior* (82 *f*,' 91 iii. *c*), and in the case of the honey-bee on the flowers of *Nepeta Glechoma* (82 *g*, 91 iii.)

One other case must be cited as showing how intelligent the actions of some insects seem to be. *Bombus terrestris,* which perforates the flowers of *Galeobdolon luteum* in and about Lippstadt (91 iii. *c*) sometimes flew to another flower without much hesitation, and without making any attempts to perforate the flowers or to get nectar in a normal way. On examination it was found that some of the flowers had changed slightly in color, and that these no longer contained nectar. The change in color was slight, but to the acute color-sense of the insect it was sufficient to indicate the absence of nectar. It is a well known fact that many flowers change their color after pollination when the secretion of nectar has ceased, e.g. *Ribes aureum*, *Gossypium herbaceum*, *Æsculus Hippocastanum,* many *Borragineæ*, etc., for the apparent purpose of indicating to insects that their services are no longer needed, thereby saving them much waste of time in probing such flowers. While this change of color in *Galeobdolon* was undoubtedly developed for a similar purpose, the insect in this case utilize this physiological difference in color in obtaining nectar in an abnormal way.

Humble-bees show preferences in the flowers they perforate. Dr. Wm. Ogle (25 *b*) states that in Switzerland he collected 100 flower-stems of a blue variety of *Aconitum Napellus* without finding a single flower perforated, while on 100 stems of the white variety, growing near by, every one of the open flowers had been perforated. This difference, Darwin thinks, may be due to different amounts of acrid matter contained in the flowers, the blue variety being distasteful to bees.

In bringing the consideration of perforated flowers to a close, I must cite a few cases showing that the perforations are made at the proper point, so that they are of the greatest service. A most remarkable case has been alluded to in *Lathyrus sylvestris.* Darwin (25 *c*) states that in *Stachys coccinea* one or two slits were made on the upper side of the corolla near the base. In *Salvia menthæfolia* (*S. Grahami*) the calyx is somewhat elongated, so that both calyx and corolla were invariably perforated. In *Antirrhinum majus* one or two holes are made on the lower side close to the nectary. In *Aquilegia* and *Aconitum* they are made in the spurs, sometimes on one side or on both sides. In *Phlomis tuberosa* slits were always made immediately above the enlargement on the tube of the corolla. The awned calyx-lobes must in a measure prevent the insect from perforating the tube of the corolla farther down. The same is true of *Lamium album* and *L. amplexicaule.*

The habit of perforating flowers is often very local. I have alluded to the perforated flowers of *Monarda Bradburiana* in the Botanic Garden. Sometime later I looked for perforated flowers of the same species in several places some twenty miles from St. Louis, but I never found the flowers perforated, so that insects are sometimes very local in their habits, as Darwin and others have shown. Focke (40) also alludes to this localization in some hybrids between *Nicotiana rustica* and *N. paniculata* (the parents of this hybrid were not touched), in one patch of which the flowers were perforated, while in another removed a little distance none of the flowers were thus treated until somewhat later, and these were undoubtedly made by the same bee, yet both patches where equally conspicuous. What should cause this localization of habit? It must, I think, be due to the individual experience of the insects, for those which had once perforated flowers always did so in this case.

Why should insects perforate flowers? Darwin (25) believes that, as a general rule, flowers are only perforated when they grow in large quantities close together; for he found in a garden where *Stachys coccinea* and *Pentstemon argutus* were growing in large numbers every flower was perforated, but at some distance from these was a small stock of *Stachys coccinea* the flowers of which were much scratched, showing that they had been visited by bees, although not a single flower was perforated. The same thing was noticed on a small stock of *Pentstemon,* growing in the same garden. The same fact holds true in *Trifolium pratense* when growing in fields, and *Phaseolus multiflorus* when grown in large and conspicuous clusters in gardens. It is a well known fact that alpine flowers grow in much larger masses than plants of lower regions. Familiar examples of our flora are afforded by *Silene acaulis, Arenaria Grœnlandica, Bryanthus taxifolius, Trifolium* sp. *Ledum,* etc. Müller (90 *h*) has shown of alpine and subalpine plants that more flowers were visited in the Alps than in the lowlands, and also that more species were perforated, as is well shown by the list of flowers which *Bombus mastrucatus* visits.

Flowers grown in large masses are conspicuous, and therefore attract many insects; and, as the perforated flowers usually contain considerable nectar, the number of insects visiting the flowers at any one time is very large, and, as Darwin has shown, (25*c* and 28) some of the nectaries are sucked dry; now, in order to save time, for the flowers would have to be probed for their nectar, the insect makes perforations. To this rule there are exceptions, as has been shown in some of the cases cited, where an insect, unable to get the nectar in a normal way, takes to perforating flowers. Müller, Loew, and others, have shown that there is a certain correlation between the length of the tongues of Hymenoptera and the flowers they perforate, as can be seen by consulting their tables on flowers and their visitors.

I have enumerated enough cases to show why flowers, and especially those with deep-seated nectar, are perforated, and shall now consider briefly the protection against such unwelcomed visitors possessed by some such flowers.

Delpino recognizes three principal modes of protection:

1. The coriaceous thick hard tubular calyx sometimes found surrounding the region of the nectar receptacle.
2. Inflated organs, like the calyx of *Rhinanthus* and the involucre of *Convolvulus sepium*.
3. A hooded or spurred calyx enclosing as a second envelope the nectariferous spurs, as in *Delphinium*, and still more effectively in *Aconitum*.

It will be well to consider these structures somewhat in detail.

In *Rhinanthus alectorolophus* there is at least a partial protection, as the calyx is inflated and the arch of the corolla is firm and smooth. Müller (90 *e*) observed a female of *Bombus mastrucatus* making unsuccessful attempts to bite holes in the tubes of the corolla of this plant. *Pedicularis verticillata* is also somewhat protected, as the calyx is globular, smooth, and compressed laterally, while the corolla has an abrupt rectangular bend within the calyx, and the upper lip is very firm. *Bombus mastrucatus* and *B. terrestris* (90 *b*) both made several unsuccessful attempts on this species.

In *Labiates* the awn-pointed lobes of the calyx are very effective, as in *Lamium*, *Melissa*, *Nepeta*, *Phlomis*, etc.

In *Antirrhinum* and *Linaria* the lips of the corolla come close together, so that only such insects can get the nectar as are able to push the upper lip back; but the flowers are often perforated, so that this is only a partial protection.

In *Symphytum officinale* and other members of the *Borragineæ* scales are developed which close over the throat of the corolla.

In *Passiflora* the throat of the calyx is crowned with a double or triple fringe of hairs. Quite as useful as this must be the intermediate and plaited folds in the corollas of some Gentians, from which teeth project into the opening of the flower. Viscid stems and parts of the flower in close proximity to the essential organs may also be of service.

The glandular phyllodia of certain *Acacias*, the involucral bracts of *Gossypium*, the petioles of *Cassia*, etc., secrete nectar, by which ants and other insects are attracted directly to them, and so do not molest the flowers. For an interesting discussion of this subject I must refer to papers by Prof. Trelease,* Th. Belt,† Kerner,‡ F. Delpino,§ O. Beccari,‖ Ernst Huth,¶ etc. etc.

Pollen is protected in various ways. A curious case of protection is found in *Ophrys insectifera*, where the labellum simulates the thorax of an insect which visits the flowers of some orchids. As this plant is self-pollinated, the mimicry may be beneficial in repelling insects.

In *Iris* the stamens are sheltered under the over-arching petal-like stigmas.

The syngenesious stamens of *Lobeliaceæ* and *Compositæ* open inwardly around the style, so that there is not much waste of pollen. The arched upper lip of labiate flowers, which is often

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* "Nectar and its Uses" in Comstock's Report on Cotton Insects, Dep't of Agriculture, Washington, D. C., 1879; "The Foliar Glands of *Populus*," Bot. Gaz., vol. vi. p. 284, 1881.

† "Naturalist in Nicaragua." London: 1874. p. 128 and 219.

‡ "Die Schutzmittel der Blüthen gegen unberufene Gäste." Wien: 1876. English Translation by Dr. Ogle, "Flowers and their Unbidden Guests." London: 1878.

§ Atti R. Università di Genova, iv. Pt. i. p. 26; "Funzione mirmecofila nel Regno Vegetale," In Memoria della R. Acc. delle Scienze dell. Istit. di Bologna, p. 21.

‖ "Piante ospitatrici ossia piante formicarie della Malesia et della Papuasia"; "Malesia;" vol. ii. fasc. t. ii. 1884: fasc. iii. Florence.

¶ "Myrmecophile und myrmecophobe Pflanzen. Sammlung naturwissenschaftlicher Vorträge," herausgegeben von Dr. Ernst Huth. Berlin: 1887.

hairy as in *Monarda, Pedicularis,* and *Castilleia,* is very effective, especially against rain and dew. The same is true of the overarching spathe in Aroids.

Ants, which from this standpoint must be regarded as entirely injurious to flowers, are prevented from getting at this nectar in various ways.*

1. Aquatic plants are protected by their isolation in water. Land plants have occasionally secured for themselves the same advantages in that certain leaves form cups around the stem, in others there is a leaf-cup at each joint, while in some there is a single basin formed of the rosette of leaves at the base. In these rain and dew not only collect, but are retained for a considerable

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* Loew has made the following very convenient classification of insects and their relations to flowers:

Hymenoptera:
1. Eutropic ("Eutrope"), Polytropic ("Polytrope"), Oligotropic ("Oligotrope").
2. Hemitropic ("Hemitrope").
3. Allotropic ("Allotrope").
4. Dystropic ("Dystrope").

Eutropic includes all *Apidæ* with the exception of *Prosopis* and *Sphecodes.* In these we have reciprocal adaptations; they collect both honey and pollen. On the whole they must be regarded as useful; in a few cases they are somewhat destructive.

Hemitropic includes *Prosopis* and *Sphecodes;* they are highly developed and have considerable freedom of movement, but these only collect nectar, like *Sphegidæ.*

Allotropic includes the social *Vespidæ,* the *Ichneumonidæ* and *Tenthredinidæ.* The members of this group feed not only on nectar and pollen, but are also carnivorous.

Dystropic includes the *Formicidæ;* they are entirely destructive. The mandibles are strong and well developed: the development of small teeth upon the mandibles enables them especially to bite and gnaw.

Diptera:
- *Hemitropic* (Conopidæ, Bombylidæ, Syrphidæ).
- *Allotropic* (Muscidæ, Empidæ, Tabanidæ, Stratiomydæ).

Coleoptera:
- *Dystropic* (Curculionidæ, Melolonthidæ, Chrysomelidæ).
- *Allotropic* (Lepturidæ, Melyridæ, Cetoniaridæ, Phalaeridæ, some Cleridæ, and Dermestidæ).
- *Hemitropic* (Nemognatha and perhaps also some Euchiridæ, Hoplidæ, and Telephoridæ.

Most of the Lepidoptera are *Hemitropic.* Loew uses the word "Heterotropic" to designate the unequal selections that insects display in going to flowers.

Anthophora pilipes and *Anthidium manicatum* visit few species, and confine themselves to bee and humble-bee flowers of *Labiatæ, Scrophulariaceæ,* etc., and are called Oligotropic, as opposed to the many-sided visits of the species of Bombus which are called Polytropic.

time, as in *Dipsacu sylvestris*, *D. laciniatus*, and *Silphium perfoliatum*.*

2. By means of slippery leaves, which often have a curved surface, over which it is impossible for ants to climb, e.g. in *Gentiana firma*. In *Cyclamen* the reflexed lobes of the corolla are turned upwards, so that ants cannot crawl over them.

3. Plants, and especially parts near the corolla, are covered with hairs and spines; these often point downwards, as in flowers of *Salvia*, *Verbena*, *Linnæa*, and *Stachys*.

4. Some plants are especially distinguished by viscid and glutinous secretions. These occur on the stem in *Silene antirrhina*, on the involucral bracts of *Grindelia squarrosa*, on the calyx and stem of *Silene noctiflora*, and on the young branches of *Robinia viscosa*, the secreting glands shrivelling up when the flowers have been pollinated.

5. Kerner believes that the milky juices of some plants, e.g. *Lactuca*, *Asclepias*, *Euphorbia*, *Apocynum*, *Chelidonium*, etc., serve to keep ants away. In an experiment, he found that an ant, placed on a lettuce-leaf, cut the epidermal tissue with its sharp claws so that the milky juice exuded, and, hardening, held the ant to the leaf.

In the cases cited, and many others of the same sort, the protection, though more or less effective, is usually only partial.

To summarize:— It has been shown that flowers with deep-seated nectar are often perforated, and that in most cases the perforations are made by insects which are unable to get at the nectar in a normal way; that *Bombus mastrucatus* is more addicted to this habit than any other European humble-bee, and following this are *Bombus terrestris*, *B. pratorum*, and *Xylocopa violacea*. Such flowers as *Vicia cracca*, *Aquilegia vulgaris*, *Linaria vulgaris*, and others, are systematically perforated, while in North America *Xylocopa Virginica* is a frequent per-

* W. J. Beal and C. E. St. John, "A Study of *Silphium perfoliatum* and *Dipsacus laciniatus* in regard to Insects," Bot. Gazette, vol. xii. p. 268. F. Darwin, "On the protrusion of Protoplasmic filaments from hairs in Leaf-Cup, *Dipsacus sylvestris*," Quar. Jour. of Mic. Sci. 1877, p. 245. F. Cohn, "Ueber vibrirende Fäden in den Drüsenharen von Dipsacus," Amtl. Bericht. der 50. Versammlung deutscher Naturforscher und Ærtze zu München, p 202 (Botan. Ztg. xxxvi. p. 122). B. D. Halsted, "Is the Cup-Plant Insectivorous?" Bull. Iowa Agr. College, 1886. p. 24. F. Ludwig, "Das Hervortreten von Protoplasmfäden bei den Drüsenhaaren von *Silphium perfoliatum*," Kosmos, Oct., 1880, viii. p. 47. Etc. etc.

forator of flowers, in some of which the nectar is in part accessible to it: that there is a certain correlation in the length of the tongues of *Apidæ* and the flowers they visit in a normal way, but when this limit is reached flowers are often perforated; that conspicuousness of plants may account for some of the perforations, but most of them are attributable to the non-adaptability of the insect to the flower; that the insect uses considerable ingenuity in perforating flowers, attacking them in close proximity to the nectary; that this is individual experience and not inheritance on the part of insects; and that perforated flowers are not necessarily sterile, but are often quite productive, as is well shown in the case of *Symphytum officinale* and *Phlomis tuberosa*.

I cannot close this paper without expressing my great indebtedness to Miss Mattie Hoke, who has drawn all of the figures directly on stone for me: to Mr. Robertson, who has kindly allowed me to use his notes on perforations; to a few correspondents, who have done several favors for me; and I am especially under great obligations to Prof. Wm. Trelease, who has assisted me in various ways.

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LIST OF PERFORATED FLOWERS.

Aconitum lycoctonum, L. 2, p. 125; 36, p. 113—*Bombus mastrucatus*, *B. terrestris*.

Æsculus glabra, Willd.

A. flava, Ait.

var. purpurascens, Gray.

Napellus, L. 90, p. 139; white var. 25, p. 428—*Bombus mastrucatus*.

Aquilegia. 46, p 43; 30, p. 114; 87, p. 424.

Canadensis, L. 54, p. 229.

Olympiaca. 74, p. 66.

vulgaris, L. 106. p. 280; 82, p. 119; 54. p. 229; 98*a*, p. 367; 74, p. 66—*Xylocopa Virginica*, *Bombus terrestris*. *Apis* is said to perforate and also use perforations.

Amsonia Tabernæmontana, Walt. Longitudinal slits made by *Xylocopa Virginica*.

Antirrhinum majus, L. 98*a*. p. 367—*Xylocopa violacea*.

Anthyllis vulneraria, L. 90, p. 248—*Bombus Lapponicus*, *B. mastrucatus*, *B. terrestris*.

Arcostaphylos officinalis, Wimm & Grabb. 90, p. 386—*Bombus mastrucatus*.

Astragalus glycyphyllus, L.

Brugmansia. 113, p. 69; 25, pp. 371 & 432 according to Fritz Müller.

Brunella grandiflora, Jacq. 90, p. 314—*Bombus mastrucatus*, *B. terrestris*.

vulgaris, L. 90, p. 315—*Bombus mastrucatus*.

Canna Indica. 98*a*, p. 367—*Xylocopa violacea*.

Centrosema Virginiana, Benthm. 109, p. 692.

Convallaria Polygonatum. 90, p. 54; 91, I. p. 208—*Bombus mastrucatus*, *Cetonia aurata*.

Cordia mixa. 30, p. 114—*Xylocopa violacea*.

Corydalis. 30, p. 114.

aurea, Willd., by one of the by flower beetles.

cava, Schweigg. 82, p. 131 — *Apis* uses the perforations of *Bombus terrestris.*

glauca, Pursh. 107, p. 65—*Bombus sp.*

solida, Schweigg. 82, p. 131; 59, p. 10 — *Bombus terrestris.*

Dicentra. 87, p. 425.

Canadensis, DC. 79, p. 66; 13, p. 68—*Bombus Virginicus.*

cucullaria, DC. 58, p. 33; 14, p. 66; 107, p. 65; 79, p. 66.

eximia, DC. 58, p. 33.

spectabilis. DC. 82, p. 129 — *Bombus Rajelius. B. pratorum, B. terrestris.* The perforations used by *Apis mellifica, Megachile centuncularis* and *Osmia rufa.*

Delphinium. 30, p. 114.

Diervilla. 54, p. 126.

Japonica. Longitudinal slits made by *Xylocopa Virginica.*

Digitalis lutea, L. 90, p. 114—*Bombus mastrucatus, B. terrestris.*

Echium rosulatum, Lge. 63, p. 152—*Bombus terrestris.*

Erica tetralix, L. 25, p. 426; 82, p. 353; 89*a*, p. 67. *Apis* and small worker of *Bombus terrestris.*

Fuchsia. 50, p. 126.

elegans, 66, p. 263.

Galeobdolon luteum, Huds. 82, p. 313; 59 p. 10—*Bombus terrestris. Apis* uses the perforations.

Galeopsis Tetrahit, L. 82, p. 314; 90, p. 312 — *Bombus mastrucatus, B. terrestris.*

Gentiana acaulis, L. 90, pp. 334-35; 87, p. 427 — *Bombus mastrucatus.*

asclepiadea, L. 90, p. 337; 87, p. 427 — *Bombus mastrucatus.*

campestris, L. 90, p. 426—*Bombus mastrucatus.*

obtusifolia, Willd. 90, p. 343 —*Bombus mastrucatus.*

Gerardia flava, L. 6, p. 49—*Bombus sp.*

lævigata, Raf. 107, p. 65—*Bombus sp.*

pedicularia, L. 25, p. 427; 3, p. 39; 4, p. 689; 98, p. 202—*Bombus sp.*

purpurea, L. 107, p. 664—*Bombus sp.*

Halesia tetraptera, L. 77, p. 51—*Bombus sp.*

Impatiens balsamina, L. 80, p. 277—*Bombus sp.*

fulva, Nutt. 112, p. 20; 54, p. 229—*Bombus Virginicus.*

noli-tangere, L. 90, p. 179; 87, p. 428—*Bombus sp.*

fulva, Nutt, 116, p. 100.

Lamium album, L. 82, p. 310; 90, p. 311; 87, p. 428 — *Bombus alticola, B. mastrucatus, B. terrestris.* *Apis* gets nectar through perforations made by other insects.

maculatum, L. 82, p. 311; 60, p. 103—*Bombus Rajellus* uses the perforations of *B. terrestris.*

purpureum, L. 30, p. 114: 89*a*, p. 47—*Bombus terrestris.*

Lathyrus. 30, p. 114.
latifolius, L. 59, p. 17—*Bombus terrestris.*
sylvestris, L. 28, p. 189; p. 25, p. 429.

Linaria. 30, p. 114.
alpina, Mill. 90, p. 277—*Bombus mastrucatus.*
striata, DC. 35, p. 57—*Croto.*
vulgaris, Mil. 106, p. 318; 53, p. 229; 98*a*, p. 367—*Xylocopa violacea.*
Lithospernum angustifolium, Michx.

Lonicera Caprifolium, L. 30, p. 114; 59, p. 10.
glauca, Hill. 53, p. 229; 30, p. 114.
grata, Ait. 53, p. 229.
flava, Sims. Perforations probably made by *Xylocopa Virginica.*
sempervirens, L. Perforations made by *Megachile brevis,* 104, p. 39.

Medicago sativa, L. 59, p. 10—*Apis*, according to Urbin.

Melampyrum nemorosum, L. 89*a*, p. 38 — *Bombus lapidarius, B. muscorum, B. pratorum, B. terrestris, Psithyrus rupestris. Apis* using perforations.
pratense, L. 82, p. 299; 97, p. 47; 89*a*, p. 36—*Bombus lapidarius, B. pratorum, B. terrestris. Apis* uses the perforations.
sylvaticum, L. 30. p. 114.

Mertensia Virginica, DC. 103, p. 111; 59, p. 229—*Bombus sp.*

Mirabilis. 25, p. 428.
Jalapa, L. 30, p. 114; 98*a*, p. 367; 57, p. 562 — *Bombus sp., Xylocopa violacea.*

Monarda didyma, L. 59, p. 229—*Bombus terrestris.*
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Nepeta Glechoma, Benth. 82. p. 320: 89*a*, p. 52; 59, p. 10—*Bombus terrestris. Apis* makes perforations, and uses those of *B. terrestris.*

Nicotiana, cross between *N. rustica* and *N. paniculata.* 40, p. 473—*Bombus lapidarius.*

Orchis. 53, p. 229.

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vernus, L. 59, p. 33; 89, p. 257—*Apis* uses perforations made by *Bombus terrestris.*

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Pedicularis Canadensis, L. 44, p. 287; 119, p. 822; 70, p. 287; 70, p. 497—*Bombus terrestris?*
foliosa, L. 90, p. 353; 87, p. 427; 87, p. 146—*Bombus mastrucatus.*
lanceolata, Michx. 119, p. 824.
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tuberosa, L. 90, p. 302; 87, p. 427.
verticillata, L. 90, p. 298—*Bombus mastrucatus, B. terrestris.*

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gentianoides, 35, p. 209.
Hartwegi, 35, p. 209.
Petunia. 53, p. 89: 69, p. 298—*Xylocopa*, *Bombus*. *sps*.
Phaseolus multiflorus, Willd. 25, p. 428; 98, p. 365; 28, p. 189; 87, p. 258 —*Bombus terrestris*.
Plumbago Capensis, 94 p. 343 —*Xylocopa Virginica*.
Plumeiria. 30, p. 114.
Polygala chamæbuxus, L. 90, p. 167; 30, p. 114; 87, p. 146; 87, p. 427—*Bombus mastrucatus*.
Primula elatior, L. 82, p. 347; 25, p. 425; 87, p. 429; 68*a* — *Bombus terrestris*.
latifolia, Lap. 87, p. 428—*Bombus sp*.
veris, 26, p. 22,
viscosa, Vill. 90, p. 369—*Bombus mastrucatus*.
Pulsatilla vulgaris, Mill. 88, p. 43 — *Bombus terrestris* robs the flower of its nectar without perforating.
Prunella. See Brunella.

Rhinanthus Alectorolophus, 90, p. 290; 87, p. 426; 85, vol. xiii.13, p. 210 —worker of *Bombus mastrucatus*.
alpinus, Bmg. 90, p. 289; 87, pp. 426-27 — *Bombus mastrucatus*, *B. pratorum*, *B. terrestris*.
Christa-galli, L. 30, p. 114; 106, p. 324—*Bombus sp*.
major, Ehr. 106, p. 314; 82, p. 295—*Bombus pratorum*, *B. terrestris*.
Rhododendron azaloides. 25, p. 432—*Bombus sp*.
ferrugineum, L. 87, p. 428—*Bombus mastrucatus*.
hirsutum, L. 87, p. 428—*Bombus mastrucatus*.
nudiflorum, Torr. 93, p. 142—*Bombus sp*.
Ribes aureum, Pursh. 16, p. 238; 9. p. 126; 113, p. 69: 25, p. 432 — *Vespa maculata*.
Cynosbati, L. 114, p. 136; 113, p. 69—*Vespa maculata*, *Formica fusca*.
Robinia Pseudacacia, L. 16, p. 238—*Bombus sp*.

Salvia coccinea. 25, p. 425; 30, p. 114.
eriocalyx, Bert. 22, p. 24—*Apis mellifica*, *Xylocopa violacea*.
glutinosa, L. 90, p. 317; 82, p. 324; 25, p. 427 — *Bombus terrestris*, *Bombus sp*.
Grahami. 25, p. 425; 30, p. 114. See *S. menthæfolia*.
menthæfolia, Ten. 22, p. 24—*Apis*, *Xylocopa violacea*.
Mexicana, L. 22, p. 24—*Apis*, *Xylocopa violacea*.
officinalis, L. 96, p. 267; 106, p. 94—*Bombus terrestris*.
pratensis, L. 90, p. 317; 87, p. 428 — *Apis* uses perforations made by *Bombus terrestris*.
splendens, 113, p. 68; 73, pp. 318, 334.

CONTRIBUTIONS FROM THE SHAW SCHOOL OF BOTANY.

No. 2.

Measurements of the Trimorphic Flowers of OXALIS SUKSDORFII.

By W. G. ELIOT, Jr.

The plant now known as *O. Suksdorfii* was for a long time thought to be a form of *O. corniculata*, but its trimorphism, together with other characters, constitutes it a distinct species. It is found in the far north-western part of the United States, where it was first collected by Nutall.

I spent a part of last summer in a locality where I could collect the flower, and, at the suggestion and with the help of Prof. Trelease, I have made some notes upon the heterogony of this species. My work, essentially, was the measurement of the styles and two sets of stamens in one hundred specimens picked at random, and the plotting of curves in order to give a graphic representation of these measurements.

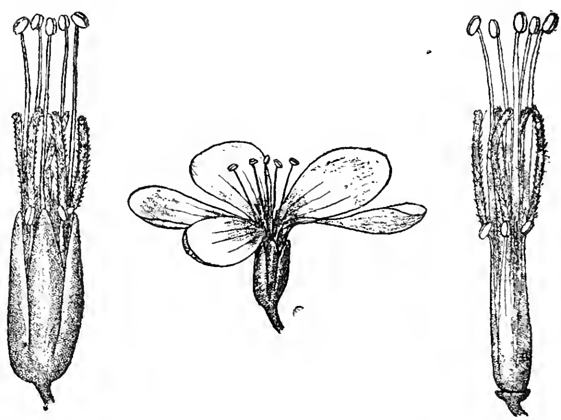


Fig. 1.—FLOWER OF *Oxalis Suksdorfii*, ×2; at the left, a flower with the petals removed, ×5; at the right, the same after removal of the calyx, ×5.

Oxalis Suksdorfii grows in abundance in the woods and fields about Portland, Oregon, and even in the yards and parks of the city. I do not know how long the flower remains blooming. The specimens which I measured were gathered June 17 and 19. The plant and flower grow larger in shady, moist places, as is quite natural.

A sketch of the flower is given in Fig. 1, which also represents the same flower after the successive removal of the petals and sepals. The drawings were made from a flower of the mid-styled form.

In the one hundred specimens measured, twenty-one were short-styled, twenty-five were long-styled, and fifty-four were mid-styled. The correspondence between the ratio of measurements and the proportionate numbers of the specimens of the different forms is noteworthy.

The four Tables following give the result of the measurements from the base of the flower, approximating accuracy to the tenth of a millimeter.

TABLE I.—*Oxalis Suksdorfii.*

MEASUREMENTS OF STAMENS AND PISTILS FROM LONG-STYLED FLOWERS.

Flower Numbers.	Pistils.	Long Stamens.	Short Stam.
1	11·5 mm.	6.0 mm.	5·0 mm.
2	11·3 "	5·3 "	4·3 "
3	11·1 "	5·2 "	4·2 "
4	10·0 "	5·5 "	4·5 "
5	10·0 "	5·3 "	4·3 "
6	10·0 "	5·0 "	4·0 "
7	10·0 "	5·0 "	4·0 "
8	9·7 "	5·1 "	4·0 "
9	9·7 "	5·0 "	4·0 "
10	9·5 "	5·5 "	4·0 "
11	9·5 "	5·0 "	4·0 "
12	9·3 "	5·0 "	4·0 "
13	9·2 "	6·0 "	5·0 "
14	9·2 "	5·0 "	4·0 "
15	9·0 "	6·0 "	5·0 "
16	9·0 "	5·0 "	4·0 "
17	9·0 "	5·0 "	4·0 "
18	9·0 "	5·0 "	4·0 "
19	9·0 "	5·0 "	3·7 "
20	9·0 "	4·8 "	4·0 "
21	8·6 "	4·6 "	3·7 "
22	8·5 "	4·4 "	3·7 "
23	8·5 "	4·2 "	3·7 "
24	8·3 "	4·7 "	3·8 "
25	8·2 "	4·6 "	3·6 "

TABLE II. — *Oxalis Suksdorfii.*

MEASUREMENTS OF STAMENS AND PISTILS FROM MID-STYLED FLOWERS.

Flower Numbers.	Pistils.	Long Stamens.	Short Stam.
1	8.6 mm.	11.0 mm.	5.2 mm.
2	6.7 "	10.5 "	5.1 "
3	6.7 "	10.5 "	4.5 "
4	7.3 "	10.3 "	5.2 "
5	8.0 "	10.0 "	5.0 "
6	7.5 "	10.0 "	5.0 "
7	7.2 "	10.0 "	5.0 "
8	7.1 "	10.0 "	4.8 "
9	7.0 "	10.0 "	5.0 "
10	7.0 "	10.0 "	4.5 "
11	4.5 "	10.0 "	3.7 "
12	7.0 "	9.6 "	4.6 "
13	7.8 "	9.5 "	4.5 "
14	7.8 "	9.5 "	4.4 "
15	7.5 "	9.5 "	4.4 "
16	7.2 "	9.5 "	5.0 "
17	7.1 "	9.5 "	5.6 "
18	7.1 "	9.5 "	4.5 "
19	7.0 "	9.5 "	5.0 "
20	7.0 "	9.5 "	4.7 "
21	6.2 "	9.5 "	4.5 "
22	7.5 "	9.3 "	4.7 "
23	7.3 "	9.3 "	4.5 "
24	7.1 "	9.3 "	4.5 "
25	6.5 "	9.3 "	4.8 "
26	6.6 "	9.2 "	4.1 "
27	8.0 "	9.0 "	4.5 "
28	8.0 "	9.0 "	4.0 "
29	7.8 "	9.0 "	4.5 "
30	7.5 "	9.0 "	4.5 "
31	7.5 "	9.0 "	4.5 "
32	7.2 "	9.0 "	4.5 "
33	7.0 "	9.0 "	5.0 "
34	7 0 "	9.0 "	4.3 "
35	7.0 "	9.0 "	4.0 "
36	7.0 "	9.0 "	4.0 "
37	6.5 "	9.0 "	4.7 "
38	8.4 "	8.7 "	4.7 "
39	7.2 "	8.7 "	4.1 "
40	7.0 "	8.7 "	4.3 "
41	7.0 "	8.7 "	4.1 "
42	7.6 "	8.5 "	4.1 "
43	7.3 "	8.5 "	4.7 "
44	7.3 "	8.5 "	4.5 "
45	7.0 "	8.5 "	4.0 "
46	6.5 "	8.5 "	4.5 "
47	6.5 "	8.5 "	4.5 "
48	7.4 "	8.4 "	3.7 "
49	7.0 "	8.3 "	4.0 "
50	7.0 "	8.2 "	4.0 "
51	7.0 "	8.1 "	4.2 "
52	7.0 "	8.0 "	4.3 "
53	7.3 "	7.6 "	4.0 "
54	4.0 "	5.0 "	3.2 "

TABLE III.—*Oxalis Suksdorfii.*

MEASUREMENTS OF STAMENS AND PISTILS FROM SHORT STYLED FLOWERS.

Flower Numbers.	Pistils.	Long Stamens.	Short Stam.
1	5·6 mm.	12·7 mm.	9·5 mm.
2	5·8 "	12·3 "	9·5 "
3	6·0 "	12·2 "	9·5 "
4	5·0 "	10·5 "	7·7 "
5	4·5 "	10·1 "	7·6 "
6	5·0 "	10·0 "	8·0 "
7	4·5 "	10·0 "	8·0 "
8	4·3 "	10·0 "	8·0 "
9	4·7 "	9·8 "	7·8 "
10	4·6 "	9·6 "	7·1 "
11	5·5 "	9·5 "	7·5 "
12	4·5 "	9·5 "	7·5 "
13	4·0 "	9·4 "	7·0 "
14	4·0 "	9·3 "	7·5 "
15	4·5 "	9·1 "	7·0 "
16	4·0 "	9·0 "	7·5 "
17	3·5 "	9·0 "	7·0 "
18	4·1 "	8·6 "	7·6 "
19	4·5 "	8·5 "	7·5 "
20	4·0 "	8·5 "	7·2 "
21	4·5 "	7·8 "	7·2 "

TABLE IV.—*Oxalis Suksdorfii.*

AVERAGE LENGTHS OF PARTS.

Forms.	Pistils.	Long Stamens.	Short Stam.
A. Long-styled Flowers	9·44 mm.	5·09 mm.	4·10 mm.
B. Short-styled Flowers	4·60— "	9·78+ "	7·77+ "
C. Mid-styled Flowers	7·08— "	9·11+ "	4·50— "

Length of pistil in A	9·44 mm.
" " long stamens in B	9·78 "
" " " " " C	9·11 "
Average length of longest part	9·44+ "

Length of pistil in B	4·60 mm.
" " short stamens in A	4·10 "
" " " " " C	4·50 "
Average length of shortest part	4·40 "

Length of pistil in C	7.08	mm.
" " short stamens in B	7.77	"
" " long " " A	5.09	"
Average length of middle part	6.65	"

From A, B, and C, rearranging according to length of part, we have

Ratio	4.10	5.09	9.44	*Average.*
	4.60	7.77	9.78	4.4 : 6.7 : 9.5
	4.50	7.08	9.11	

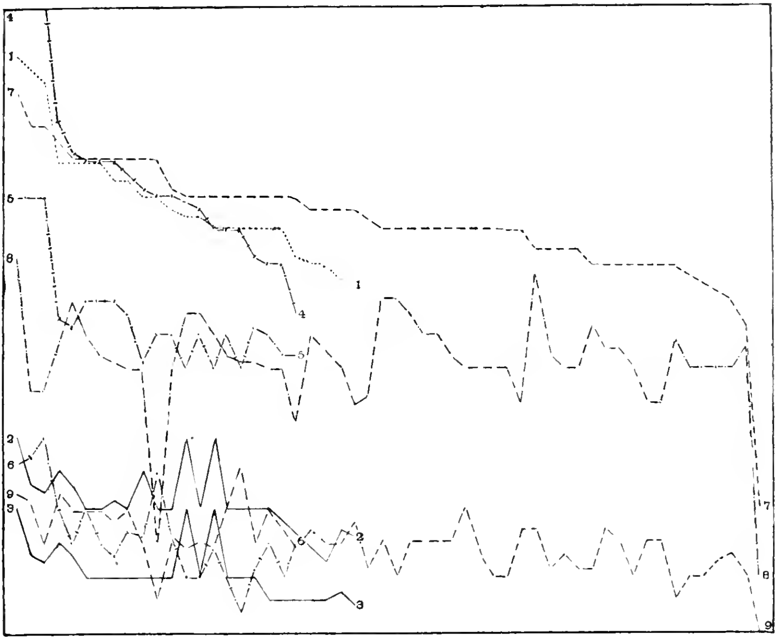
Of the one hundred specimens measured, as has already been stated, the numerical portion of the different forms was

$$21 : 25 : 54 = 4.1 : 5.0 : 10.8$$

From Table IV. it will be seen that the pistils in either the long-styled or short-styled forms are intermediate in length between the two sets of stamens of the other two forms; while the pistils of the mid-styled form are intermediate between the longer parts of the two other forms. In the long-styled and short-styled forms the distance between the stigmas and nearest set of anthers is greater than the distance between the anthers, in a ratio nearly constant.

In the Diagram here inserted, a graphic representation of the measurements is given. In plotting the curves the flowers were arranged according to the length of the longest part. This causes the curves 1, 4 and 7 to descend uniformly, without interfering necessarily with their relations. They interlace, thus showing that in the three forms the length of the long part is nearly the same. The curve *4* does not interlace so well with *1* and *7* as it should, because the greater number of points plotted extends it away to the right. In the curve *7* the stamens of one of the flowers were abnormally small, and I call attention also to the two very long sets of stamens (12.7 mm. and 12.3 mm.) of the first two flowers, whose points in the curve lay outside the limits of our coördinate paper. It will be seen by referring to Table IV. that the average length for the long stamens of the long-styled flowers is unexpectedly below the average for the middle part of the other two forms. This is seen very nicely in the Diagram,

Fig. 2, where the curve 2 intersects the lower group rather than the middle group, to which it properly belongs.



OXALIS SUKSDORFII—No. 2.

Diagram, compiled from Tables I. to III., showing the relative lengths of stamens and pistils in 100 flowers: — 1, Pistils of long-styled flowers; 2 and 3, stamens of same; 4 and 5, stamens of short-styled flowers; 6, pistils of same; 7 and 9, stamens of mid-styled flowers; 8, pistils of same.—The bottom of the diagram represents a height of 3.2 mm. from the bottom of the calyx; and the top of the diagram, a height of 12.1 mm. above the same level.

The curves for the stamens of the long-styled flowers, the styles and short stamens of the mid-styled flowers, and the short stamens and styles of the short-styled flowers, run nearly parallel, showing that the usual distance between the lower sets of parts is more nearly constant than that between the longest and next shorter part.

In *O. Sukdsdorfii* the fertilization of the flowers is effected by insects. There are always two sets of stamens to one set of pistils, and therefore, with insects of ordinary size, there is double the opportunity to carry pollen away, and the opportunity to carry away double the amount that might be carried away from the flower if there were but a single set. This last is a natural provision, since the insect in flying about wastes some of its pollen load.

Trimorphism in flowers is a device for their surer and more abundant cross-fertilization. In studying the fertilization of flowers, one sees countless examples of marvelously intricate and as it were ingenious mechanical devices for cross-fertilization. In trimorphic species the effectiveness of the device depends more upon mathematical principles—aside from the sterility of illegitimate unions, which Darwin and Hildebrand have demonstrated experimentally.

A small insect reaching for nectar in the long-styled form would not leave any pollen on the stigmas; and a small insect crawling into the short-styled flower might not carry pollen away. There are three forms of flower, and, speaking roughly, we may divide the insects which seek these flowers into two classes, large and small. Consequently, two insects, one large and one small, flying from one flower to another, have each a choice, so to speak, of six combinations. In all six combinations, a large insect (a hive-bee, for instance) would probably effect fertilization, while an insect 5 mm. in length would probably effect only three fertilizations. If, on the contrary, all the flowers were of one form, it is evident that some insects, even if they went from flower to flower all day long, might fail to fertilize any flower. As it is, the flower is arranged for any insect, within certain limits of course.

Assuming that the three forms of the trimorphic species occur in the ratio of 4, 5 and 11, and that an insect requires a minute to go from flower to flower; and, given the size of the insect and the number of flowers in the field, a calculation of the probabilities as to the number of fertilizations effected could be made. The result of such a calculation would serve only to give one an idea as to the mathematical principle involved. But this calculation neglects altogether the fact that an insect could get a sufficient burden of pollen from one flower to fertilize perhaps a dozen others; and, too, we would have to take into consideration the fact that an insect, instead of making one of the six combinations, might fly from one flower to another of the same form, and thus effect fertilization; yet cross-fertilization between flowers of the same form is effected in only about one-half the cases, as is shown by some of Mr. Darwin's experiments upon other trimorphic species.

Considering that *O. Suksdorfii* is an insect-fertilized flower, its great abundance can be accounted for by its excellent adaptation to the law of chances; and this also might be held to account for the predominance of the mid-styled flowers, for in these the stigma is at a point midway between the anthers (in other words, the flower is the average of the other two forms), and any insects over 7 mm. in length might effect fertilization.

I make mention in closing of two abnormal flowers, or "freaks," which I came upon while making my measurements. The one was a flower of the mid-style form, and contained six stamens—the sixth bearing, instead of an anther, a petal-shaped appendage.

The other specimen may be best described by referring to Table V.

TABLE V.—Abnormal Flower of *O. Suksdorfii*.

MEASUREMENTS OF STAMENS AND PISTILS.

Stamens.	Color of Anther.	Length.
1	Bright yellow	9·1 mm.
2	Dull yellow	7·7 "
3	Lighter yellow	6·7 "
4	Bright yellow	5·8 "
5	Buff	6·0 "
6	Grey	5·5 "
7	Grey	5·0 "
8	Darker grey	4·5 "
9	Dark grey	4·0 "
10	Dark grey	4·0 "
Pistils		5·0 "

Both of these specimens may be illegitimate offspring of the species, as similar examples in other heterostyled plants have been described by Mr. Darwin, or they may be merely effects due to unknown causes.

Observations suggested by the preceding Paper.

By William Trelease.

While engaged in a systematic study of North American *Geraniaceæ* last winter, I was obliged to give considerable time to the yellow-flowered *Oxalis* that has commonly gone under the name of *O. stricta*, now reduced to varietal rank under the name of *O. corniculata;* and I had not gone far before I perceived that the subject in hand was one of unusual difficulty. Caulescent forms of this genus, with trifoliolate leaves and (mostly small) yellow flowers, are found over the larger part of the globe; and as those of different countries differ considerably in size and habit, they have been described under a variety of names. Even the American forms have no less than ten names. But a comparison of the plants from several countries shows, that, while they may be quite different from other species associated with them, they cannot in general be characterized with sufficient precision to justify their separation from each other as distinct species, without adopting for them a scale of specific characters much more trivial than those employed for other sections of the genus. For this reason the disposition of botanists most familiar with plants of large range, is to unite them under the Linnæan *O. corniculata*, retaining varietal names for the most distinct forms.

A preliminary comparison of our North American plants led very readily to the same conclusion. Utilizing the customary characters derived from habit of growth, pubescence, presence or absence of stipules, etc., our plants of this section go together very well, although the stout caudex of the southwestern *O. Wrightii* may properly be held, in so far as our flora is concerned, as of specific value; yet in a monograph of the entire genus I doubt if it would be so considered by many botanists whose opinion is authoritative. Excluding this, our forms of *O. corniculata* are: *O. corniculata*, proper, which varies much, and is the first to bloom about St. Louis, where, as it first comes up, it is recognized at a glance from its white appressed pubescence, rather large bright yellow flowers, and squarrose stipules—at length becoming remote as the internodes of the stem elongate. In dry soil, over a considerable part of the country, a dwarf form occurs through the summer, and is chiefly known from its small but evident stipules, adnate to the base of the petioles. A third form, common in flower-pots in the cactus-houses of Cambridge and St. Louis, and presumably found in similar situations elsewhere, differs in its slender trailing stems. Some of these forms have their foliage or even flowers somewhat tinged with purple ; but a fourth form, introduced at the Garden for the edging of flower-borders, is of a very deep red-purple color, and, as it shows a strong tendency to persist where it has once been cultivated, I suspect that the St. Louis botanists must take it into account. A creeping plant of the Gulf region, which reappears in California, has unusually large and apparently variable flowers, but for the present may be placed under *O. corniculata*, although it requires further study in the field. The last form that I have referred here is the old *O. stricta*, with a more compound inflorescence, more erect habit of growth, often woolly pubescence, and no stipules. While this is quite distinct when most typically developed, it approaches the dwarf *corniculata* on the one hand, and the large-flowered variety on the other, and cannot be regarded as more than a pretty well characterized variety or subspecies of the former.

Aside from the characters that have been referred to, others exist in some cases which are capable of influencing our judgment regarding the species of this group. These characters are derived from the flowers. The large size of those produced by some plants that have been referred to *corniculata* or *stricta* has struck a number of observers, but in itself has rightly been considered insufficient for their separation. As I learn from his manuscript notes on specimens in the Torrey herbarium, the late Thomas G. Lea noticed that the stamens and pistils of the large-flowered plant of the Middle States differ from those of the true *O. stricta* in their relative lengths ; but he attributed the differences to mere variability. In reality this plant, which appears to be the *Oxalis recurva* of Elliott, is trimorphic, like a very considerable number of species belonging to other sections of the genus ; and this fact, taken in connection with other characters that alone would but imperfectly serve for its separation, marks it as very distinct from all of the forms of *corniculata*.

In restoring *O. recurva*,* which has long been lost as a synonym of *O. stricta*, I found that it has an extremely close representative in the Oregon plant that forms the subject of Mr. Eliot's paper. This differs mainly in its smaller size and more deeply notched leaflets, destitute of a dark marginal line found on those of *O. recurva*. If the two plants occurred together, or in adjacent regions, one might question the propriety of regarding them as more than varieties of a single species; but the complete isolation of *O. Suksdorfii*, which is said to be very abundant about Portland, Oregon, but appears to be very local in its occurrence, weighs very heavily against this union. Both are peculiarly American species, and without much doubt both are descended from an ancestral form essentially like *O. stricta*.

The trimorphism of *O. Suksdorfii*, which was clearly shown by herbarium specimens, is demonstrated to entire satisfaction by the measurements made by Mr. Eliot. The diagram made by plotting his measurements on coördinate paper, and connecting the points so obtained, shows at a glance the peculiarities of this trimorphism, though it is probable than in examining a thousand or more plants the relative number of long, short, and mid-styled flowers would have been more nearly equal; and the last measurements on the sheet — from a very short mid-styled flower — carries the curves for this form very much below their normal level.

In the diagram of a trimorphic species without variability, one would expect to find the lines 1, 4, and 7 coincident at the top of the paper; 3, 6, and 9, at the bottom; and 2, 5, and 8 superposed across the middle of the sheet With a small amount of variability in the flowers, each set of three curves should interlace and remain quite distinct from the other sets. This is, indeed, very well shown in the upper set (1, 4, and 7), and, as Mr. Eliot has observed, would be still more evident if a like number of each kind of flowers had been measured, so as to prolong all of the curves across the sheet. The same relations are observable between 3, 6, and 9.

On seeing the curves for the first time, I was immediately impressed by the fact that only two (5 and 8) of the other set lie

* Memoirs Boston Soc. Nat. Hist., vol. iv. No. 4. . . ; Bot. Gazette, xii. 166.

across the middle of the diagram, while the third (2) of this set is displaced so much as to interlace with the lower set. The fact is remarkable.

In 1881, I was struck by the absence of the mid-styled form of our common *O. violacea,* which, from the structure of individual flowers, should be trimorphic. For purposes of comparison, I have rearranged the measurements made at that time,* according to the longest organ of each flower, and have plotted them on the scale used by Mr. Eliot—Fig. 3.

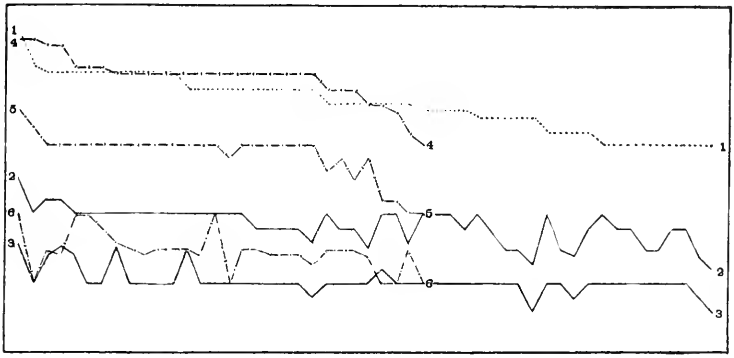


Fig. 3.— OXALIS VIOLACEA.

Diagram compiled from tables published in the American Naturalist (1882), pp. 14, 15, showing the relative lengths of stamens and pistils in 81 flowers: — 1, Pistils of long-styled flowers; 2 and 3, stamens of same. 4 and 5, stamens of short-styled flowers; 6, pistils of same.—The bottom of diagram represents a height of 1 mm., and the top a height of 6 mm. above the bottom of the calyx.

The percentage relations of the different forms in 100 plants of *O. Suksdorfii*, and 81 of *O. violacea*, are as follows:

	O. Suksdorfii.	*O. violacea.*
Long-styled	25	63
Mid-styled	54	0
Short-styled	21	37

These proportions would doubtless vary toward uniformity in a much greater number of measurements, but I believe that the indications they give are fairly reliable. In both species the short-styled form is less abundant than the long-styled; but the mid-

* From a paper in the American Naturalist for 1882, p. 13.

styled form is (in our wild plant, of which perhaps 1,000 individuals have been examined) wanting in *O. violacea*, while it is more abundant than both other forms in *O. Suksdorfii*. Observations on the fertility of these species are lacking, but Mr. Darwin has shown that the short-styled flowers of dimorphic Primulas are most fertile,* and the same rule seems to apply to trimorphic plants, with the single exception of *Lythrum salicaria*,† where the mid-styled is the most fertile form. It is, therefore, impossible for us to draw any inferences from a comparison of the fertility of the several forms with their relative abundance.

In *O. violacea* the curve (2) representing the longest stamens of long-styled flowers is depressed to about the same relative position as in *O. Suksdorfii*; so that it is safe to say, that, aside from differences depending upon the greater length of all the parts in *O. Suksdorfii*, the diagrams of these two species would be essentially alike, were the mid-styled form of *O. violacea* to be found anywhere in abundance.

There is doubtless a reason for the depression of the longer stamens in long-styled flowers of these species, but it has escaped me. While studying *O. violacea*, I fancied that it might be an approximation of the two sets of anthers indicating an approach to normal dimorphism; but no such approximation is shown in the short-styled flowers, as may be seen by comparing curves 4 and 5, and the occurrence of the same feature in *O. Suksdorfii*, which, as has been shown, has the mid-styled as its predominant form, entirely invalidates this conclusion.

It is to be regretted that we have no reliable average data on which to base comparisons with other trimorphic species of the genus. The rose-purple species of the Southwest, which are related to *O. violacea*, and may be found to resemble it very closely in their floral characters, are good subjects for the study of resident botanists; and the botanists of Cincinnati, who have access to an abundance of *O. recurva*, may easily make the necessary measurements for this species. It is also very desirable that someone who has access to enough individuals of the Californian and southern creeping plant that I have called *O. corniculata*, var. (?) *macrantha*, should make an extendd series of measurements of

* "Different Forms of Flowers," p. 20.

† Darwin, l. c. 257.

its flowers, for it is difficult to say from herbarium specimens whether they are trimorphic, or, as I have thought, merely extremely variable in the relative length of stamens and pistils.

Measurements to determine the heterogony of a doubtful plant are best made by gathering at random 100 or more flowers from as many different plants, and recording the length of each set of stamens and of the pistil of each from the base of the flower, in millimeters and decimals. Projections which show the relations of these graphically, are then readily made on coördinate paper. At the same time, the pollen-grains of as large a number of flowers as possible should be measured : for the general rule is that those from the longest set of stamens are largest, and those from the shortest set, smallest ; and any difference in the size of the stigmas of the different forms of flowers, or of the length of their papillæ when they are roughened, should be recorded. In addition to this work, a patient and careful experimenter, who lives where any of our heterogone plants grow abundantly, may do valuable work in determining the relative fertility of what have been called legitimate and illegitimate unions between the different forms, by Mr. Darwin, whose book on different forms of flowers in plants of the same species is the best possible guide for any work of this nature.

Anomalous densities of fused Bismuth.

By C. LUEDEKING, Ph.D.

Presented before the St. Louis Academy of Science Dec. 19, 1887.

Water has, as is well known, anomalous densities. Down to 4° C. it contracts in volume, whilst from 4° to 0° (its freezing point) it presents the anomalous phenomenon of expansion. If prevented from freezing it even continues expanding below 0°, presumably, until it reaches a density corresponding to the density of ice at that especial temperature, when it will contract on further cooling. We have no explanation for this phenomenon that can be called at all satisfactory.

The phenomenon has been thought to be caused in some manner by, or to have a dependence on, the fact that water at the moment of solidification expands greatly; and it has been supposed that ice molecules are formed at these temperatures of anomalous densities, and, remaining in solution, are the cause of expansion of volume.

However, all other physical constants such as specific heat, optical properties, etc., fail to demonstrate that such is the case. We must for the present content ourselves and await further developments of our knowledge of the exact relationship of the molecular states of liquids and solids.

To my knowledge the case of water stands isolated in respect of these anomalous density phenomena. I have been unable to find any other in the literature at my disposal. It seemed desirable to ascertain whether other substances present similar phenomena (anomalous densities), and it naturally suggested itself by analogy to select such as also expand greatly on solidification.

Sulphate of mangnesium and sulphate of sodium are salts belonging to this category, whilst among metals we have notably bismuth.

The experimental difficulties in case of the first two substances are exceedingly great, and it was impossible to obtain any results. With bismuth the case stands differently, and I beg herewith to describe the mode of experiment and give my numerical data.

The dilatometric method was used, and as dilatometers ordinary tin-case mercurial thermometers. A scale was etched on the stem of each, and this latter then bent at right angles two or three inches from the tip, which had previously been cut off. The metal parts were all discarded. The value of the scale was determined in all parts by the well known method. The entire instrument was then weighed after heating to 300° C., the mercury distilled out, and then weighed again empty. Thus the volume of the dilatometer was ascertained at the temperatures of experiment, viz. from 250° to 300° C. Also the weight of the glass of the instrument was thus ascertained. It was then refilled, placed in a combustion furnace, and, after the mercury had all been distilled out, the end of the stem, bent at right angles and protruding from the furnace, instantly inserted into molten bismuth. When the bulb was now allowed to cool, the mercury vapor contained therein condensed and molten bismuth was forced into the bulb by atmospheric pressure, filling it wholly. The protruding stem was then seized by means of a pair of tongs and the dilatometer rapidly taken from the furnace and plunged into a mercury bath having a temperature of 300° C. This was allowed to gradually cool, and the readings of the volumes of the bismuth were made just as in an ordinary mercurial thermometer. By means of a thermometer the temperatures of the bath were known during the course of experiment. It will be seen that the whole method consists merely in the construction of a bismuth thermometer out of a mercurial thermometer. The volumes of the instrument being known at each temperature, the various densities of the bismuth at different temperatures were thus determinable. Before sufficient skill was acquired to carry out the experiments satisfactorily months of practice were required, the details to be observed for successful work being quite numerous and unforeseen.

The results may be entirely vitiated if the dilatometer is allowed to cool to the solidification temperature of bismuth very rapidly. The bismuth under such circumstances rises with great rapidity and suddenness, through the entire length of the capillary stem, immediately before the bulb bursts. The reason of this is easy to find. The bismuth is cooled from the walls of the bulb and deposits crystals on them where they are least thick first, whilst the rest of the bismuth is still liquid and these grow towards its centre. The inner liquid portion is forced up into the capillary from this cause until the capillary itself becomes clogged with bismuth crystals, when the bulb bursts with a sharp crack.

The only way of avoiding this is, of course, by having a large bath of mercury and allowing the temperature to sink very slowly indeed. As soon as an expansion is observable, it can be identified as being due to anomalous behavior of liquid bismuth by very gently raising the temperature and reversing the process, when the bismuth will contract instead of expanding.

Not so when crystals are the cause of the expansion. It was utterly impossible to check the growth of the crystals, prevent further expansion, and the bursting of the bulb in a few seconds of time following, even by raising the temperature ever so quickly. The phenomena are quite different, and cannot be mistaken the one for the other.

I herewith give the records of my two most successful experiments:

	No. I.	No. II.
Wght. dilatom. + mercury at 300° C.	11·570 grms.	14·742 grms.
Wght. dilatom.	7·722 "	9·160 "
Wght. mercury	3·848 "	5·582 "
Volume of 20 divisions of scale	0·00102 *c.c.*	0·00151 *c.c.*
Volume of bulb and capillary	0·29887 *c.c.*	0·43355 *c.c.*
Wght. bismuth in dilatometer	2·814 grms.	4·082 grms.
Specific gravity bismuth at 280°	9·415 +	9·415 —
Temperature of maximum density of bismuth (Not readily and sharply determinable.)	near 268° C.	near 270° C.
Am't of rise of bismuth from maximum density to bursting of bulb	½ div.	½ div.
Temperature bursting of bulb	260° C.	261° C.

Evidently the point of maximum density of molten bismuth lies very near 270° C. The character of the observation and the high temperature place a more exact determination out of question. On further decrease of temperature it expands, presenting anomalous densities, and this expansion is considerably less than for water, so that its anomalous behavior is not so pronounced as is that of water. The actual amount of anomalous expansion calculated from the data given is for:

No. I.	No. II.
0.0000853 +	0.0000870 +

The actual amount of anomalous expansion of water according to Volkmann (Wied. Ann. 14, 260) is 0.000122.

The close coincidence of results for the two dilatometers makes it quite probable that they are a close approach to the actual magnitude.

It was an easy matter to measure, in conjunction with these observations of anomalous densities, the expansion of liquid bismuth itself in the range of temperature of the experiments. The co-efficient of expansion of liquid bismuth between 270° and 303° C. was determined by comparing the readings of the mercurial and bismuth thermometers between those temperatures. The value of the divisions of the bismuth thermometer was determined by first filling it with mercury and observing the readings between the temperatures above mentioned. A direct comparison with a mercurial thermometer was thus possible. It was ascertained that the bismuth column moved over only $\frac{4}{15}$ of the distance of the mercury column between 270° and 303° C. Taking, therefore, the mean co-efficient of expansion of mercury, according to Landolt and Börnstein, at 0.00016595, it follows that the mean co-efficient of expansion of bismuth between these same temperatures is 0.00004425.

The mean co-efficient of cubical expansion of solid bismuth between 0° and 100° is, also quoting Landolt and Börnstein, 0.0000411.

The expansion at the moment of solidification of liquid bismuth is, according to Marx, about 3 p. ct. The expansion at the moment of solidification of water is about 9 p. ct., being three times that of bismuth. We may on general grounds, supposing that the mechanism of solidification is the same for bismuth as for water, infer that the expansion from the point of maximum density of bismuth to the point of solidification is less for bismuth than for water. Our experiments have proven this to be the case, although the exact quantitative ratio, i.e. whether also the anomalous expansion of bismuth is $\frac{1}{3}$ that for water, cannot easily be established. That it is considerably less than the anomalous expansion of water is quite certain from our data.

The bismuth used throughout these experiments was the C. P. preparation of Merck.

The mercury vapor in the bulbs of the dilatometers amounts to only a few hundredths of a percent of the bismuth introduced, and could not have exercised any great influence on the experiments.

Mr. G. Vicentini ("Sulla variazione di volume di alcuni Metalli," etc., Torino, 1886), experimenting also by the dilatometric method, obtained results which differ in every respect from mine, and it will be necessary to give herewith his results and a criticism of his method. He finds the mean co-efficient of dilatation of fused bismuth between the temperature of fusion and 300° C. to be $\alpha = 0.000112$, or very nearly three times the value given as result of my experiments.

He also finds that bismuth has its maximum density in the fused state at the temperature of solidification, therefore has no anomalous expansion as is the case with water.

The following are the essential dimensions of his two dilatometers differing most from one another in sensitiveness. W is the volume in cub. cent., and w the volume of one division of the scales.

	I.	II.
$W =$	6.278	4.1965
$w =$	0.00667	0.802498

The sensitiveness of my dilatometer No. I. is 6.1 times as great as No. I. and 3.5 times as great as No. II. of Vicentini's dilatometers. It is apparent, therefore, that the anomalous expansion of bismuth in Vicentini's most delicate dilatometer would be $\frac{1}{7}$ of one division of his scale if my results are numerically correct, which, considering the difficulties attending the observation from a variety of causes, would no doubt be very likely overlooked. The anomalous expansion of water in that same dilatometer would only be apparent by a rise of $\frac{1}{5}$ division on the scale. I think, therefore, that we are justified in the conclusion that the dilatometers used by Vicentini were not sensitive enough for solution of the question concerning anomalous expansion of fused bismuth.

I now proceed to compare his co-efficient of expansion of fused bismuth with that obtained in my experiments. It is nearly three times as great. In the extensive series of experiments made by Vicentini, his results agree very well with one another. I presume, therefore, that the difference is due to a constant error in the method, which I think is to be found in his mode of filling the dilatometers. We know how tenaciously air adheres to glass vessels, and how difficult it is to get rid of it. Even that dilatometer par excellence, the mercurial thermometer, contains air in appreciable quantities in most cases. Vicentini in simply filling his dilatometers with bismuth, and without resorting to the known methods of freeing them from air, must have quite a constant error in his absolute results. His co-efficient would be too high from this cause, whilst mine must be comparatively free from such influences.

Chemical Laboratory Washington University.

Synopsis of the Family of Pselaphidæ.

By Dr. Emil Brendel, of Cedar Rapids, Iowa.

I. Antennæ approximate, inserted beneath, prominent, porrected contiguous tubercles. - Pselaphini

a''' } Posterior coxæ distant. Tarsi with two equal claws.

b'''' Maxillary palpi, the last two joints similar, in form like the cotyledons of an acorn, without appendages. Antennæ robust, moniliform, the last two joints of the max. palpi compressed fusiform - - - - - Ceophyllus Le Conte

Antennæ by the last three joints clavate, the last two joints of max. palpi lunate, the last longer. Cedius Le Conte

b''' Antennæ clavate. Max. palpi, the last three joints with lateral setiform appendages.

Max. palpi, the last three joints triangular, appendages short - - - Tmesiphorus Le Conte

Max. palpi, last three joints oval-transverse. appendages very long - - Ctenistes Reichenbach

b'' Antennæ moniliform. Max. palpi minute, the basal joints hidden, the last two connate, together forming a globular club - - Chennium* Latreille

b' Antennæ clavate by the last three joints. Max. palpi, last joint elongate with a terminal seta. *Pytna* Casey ; Tyrus Aubé

Antennæ clavate by the last joint, which is enormously enlarged. Max. palpi, last joint very long cylindroid, rounded at top - - Cercocerus Le Conte

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* The genera *Atinus* Horn and *Biotus* Casey do not differ more from the European species of *Chennium* than these species among themselves ; the uncertainty in respect to the number of palpal joints, being in all the *Pselaphidæ* four, does not justify a separation from Latreille's genus.

a Tarsi with a single claw. Posterior coxæ distant.
Max. palpi excessively long, the second and fourth joint pedunculate-clavate, very long. PSELAPHUS Herbst
Max. palpi long, the second joint clavate-pedunculate, the third triangular, the fourth long securiform - - - - - TYCHUS Leach

a' Posterior coxæ proximate. Tarsi with a single claw. Body linear, depressed - RHINOSCEPSIS Le Conte

II. Antennæ distant, inserted on the sides of the head beneath short, distant, not porrected tubercles.

a' Posterior coxæ distant. Claws, only one fully developed.

b''' Body broad, transversely elliptico-cylindrical in the cross-cut. Abdomen more or less broadly margined.

c'' Abdominal margin retuse, narrow; dorsal segments subequal: the two basal ventrals longer; elytra narrow-shouldered, very long. Vertex bifoveate.
Last palpal joint long-securifrom, with a rudimentary hair-shaped second claw. BYTHINUS Aubé *(Machærites)*
Last palpal joint ovate-acuminate, short; tarsi with a single claw - - EUTRICHITES Le Conte

c' Abdominal margin broadly retuse, the basal segments of the dorsum and ventre much longer, tarsi with a single claw (*Bryaxini*).
Vertex bifoveate or foveæ wanting, prothorax unifoveate, antennæ 10-jointed with the club 3-jointed; body broad, sexual marks on the intermediate thighs, elytral lines and abdominal carinæ long parallel - DECARTHRON Brendel
Vertex not foveate, prothorax faintly trifoveate, undersurface of the head bicarinate, body broad, antennal club 3 jointed - - NISAXIS Casey

Vertex and pronotum trifoveate, body broad, each elytron with a long discal line, antennæ with a 3-jointed club, undersurface of the head unicarinate - - - - - BRYAXIS Leach

Vertex bifoveate with a transverse frontal impression and obsolete circumambient sulcus, prothorax trifoveate, only the last antennal joint enlarged, body elongate - - EUPSENIUS Le Conte

Vertex bifoveate, different in the sexes; prothorax unifoveate, elytral discal lines short, body elongate - - - VERTICINOTUS Brendel*

b'' Body more elongate, convex; abdominal margin linear, narrow; prothorax with faint punctiform fovea or none.

Vertex bifoveate, elytral lines wanting, abdomen at the base without carinæ, antennal club 3-jointed - - - - SCALENARTHRUS Le Conte

Vertex not foveate, elytral lines wanting, dorsal abdominal base bicarinate, antennal club one-jointed - - - - - PSELAPTUS Le Conte

Vertex with four faint foveæ, different in the sexes; prothorax bifoveate, with a flat basal transverse sulcus; elytral discal lines obsolete or wanting; sutural lines present, abdominal basal carinæ present; sexual differences in the vertex, antennæ and anterior tibiæ: tarsi with two unequal claws - - - ARTHMIUS Le Conte

b' Body circulo-cylindrical, narrow elongate, very convex; abdominal margin with the edges not parallel on each segment triangular the external

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* *Verticinotus* n. g. separated from *Decarthron*. The male was formerly described as *Decarthron cornutum*, the female as *Bryaxis inornata*. The genus contains till now two species, one discovered in Iowa, the other in Florida. Last January I intended the name *Anchylarthron* for this genus, which, being rather an improper designation, I retracted it from being included in my pubilcation through the American Entomological Society of Philadelphia. Notwithstanding it was published therein, probably by oversight.

edges obsolete; vertex arcuately impressed; prothorax with two or three longitudinal grooves, two unequal claws - - - - BATRISUS Aubé

a Posterior coxæ approximate.

d''' Body circulo-cylindrical, narrow; vertex arcuately impressed, prothorax without longitudinal sulcus, the last antennal joint only enlarged, tarsi with a single claw (*Trimiini*).

Elytral base bifoveate, no subhumeral fovea, head larger (*Trimiopsis* Reitter) - - TRIMIUM Aubé

Elytral base trifoveate with a subhumeral fovea, head smaller - . - - ACTIUM Casey

d'' Body elliptico-cylindrical, convex, broader, the last three antennal joints enlarged, head transverse, prothorax with sharp straight linear longitudinal and basal sulcus crossing each other, tarsi with two unequal claws (*Trogasterini*).

e'' Prothorax at the sides not spinous.

Elytra each with three basal foveolæ, sutural line and two shallow longitudinal discal impressions, body uniformly tapering towards the head. CONOPLECTUS Brendel*

Elytra with four basal punctures, each with a sharp line, the discal ones abbreviated. (*Rhexidius* Casey) EURHEXIUS† Sharp

e' Prothorax at the sides spinous.

Prothorax armed on the sides with a single sharp tooth, elytra with three discal lines (*Oropus* Casey) - - - - - - TROGASTER Sharp

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* The genus *Conoplectus* is founded on *Euplectus canaliculatus*, having a second rudimentary claw, the fourth dorsal segment not prolonged, and an entirely different form of the body than *Euplectus*.

† A few months after Sharp's publication this genus was published by Casey by the name "*Rhexidius.*"

Prothorax twice as wide as long, sides with three recurved spines, elytra with one discal line, antennæ geniculate - - - - RHEXIUS Le Conte

d' Body depressed, antennæ thicker towards the apex.

f'' Tarsi with a single claw, antennal club 3-jointed. Vertex arcuately impressed, not produced in front. Body broader, lateral margin of the pronotum crenate, prosternum carinate, fourth dorsal segment not prolonged - - - - - THESIUM Casey

Body slender, pronotum with lateral longitudinal grooves, prosternum carinate, fourth dorsal not prolonged - - - - - - FALISCUS Casey

Body linear, lateral margin of the pronotum simple, the fourth dorsal segment prolongate EUPLECTUS Leach

f' Tarsi with two equal claws. Body linear, antennal joints gradually slightly larger towards the apex (*Sagola* Sharp, *Sonoma* Casey) - FARONUS Aubé

On the scale value of the Dellman Electrometer used by Dr. A. Wislizenus.

By Francis E. Nipher.

In the Transactions of this Academy, vol. ii., pp. 115, 287, 414, 526, Dr. Wislizenus gives a table of observations on atmospheric electricity with a Dellman electrometer. In 1875 the writer visited Dr. Wislizenus, and, as he was then unable to make further observations with the instrument, he consented to deposit it in the physical cabinet of Washington University.

The series of observations made by him was the first, and for years the only series made in this country, and, in order that the potentials measured by him my be known in volts, the writer has made a comparison of the instrument with a Thomson electrostatic voltmeter. The source of electricity was a Rowland water battery consisting of four plates, having in all 2,500 cells.

The battery was first examined to determine whether any of the cells were short-circuited. This was done by cutting out the cells fifty at a time, and reading the potentials on the Thomson instrument. This determination was repeated at various times and the battery was found to give very constant results, so that the potentials could always be determined by simply determining the number of cells in circuit. This was the more necessary as the Thomson instrument does not give reliable values below 500 volts.

The Dellman instrument is so constructed that when the needle is at zero it stands directly over the bar which is to repel it. The needle cannot therefore be brought to zero by turning the torsion-head, as the needle when charged would then be in an unstable condition. The arrangement of the torsion-head is such that it was evidently not intended to be used in this manner. The measurements were made by first reducing the whole instrument to zero potential, adjusting the needle to zero by means of the torsion-head, and then charging the deflection-bar and needle, and reading the deflection of the needle. This was the method used by Dr. Wislizenus.

The needle was found to be slightly bent laterally, so that the ends could not be brought to zero when the centre of the needle was directly over the bar. It was not quite at right angles to the glass fibre, so that one end would touch the bar before the other did. The vertical distance from the needle to the bar was therefore a matter of some uncertainty, and slightly different adjustments, which all seemed equally good, gave readings varying as much as fifteen per cent.

After taking a number of series of readings a smooth curve was drawn through the points determined by the readings of the needle and the known differences of the potential, the curve being so drawn as to best satisfy the observations. The scale values are given in the annexed table, where δ is the reading of the needle and v is the corresponding difference of potential in volts.

St. Louis, March 8, 1888.

δ.	v.	δ.	v.
1	2	32	85
2	4	34	95
3	6	36	109
4	8	38	124
5	11	40	139
6	13	42	155
7	15	44	164
8	17	46	188
9	19	48	209
10	22	50	230
11	24	52	250
12	27	54	270
13	29	56	291
14	31	58	311
15	34	60	332
16	36	62	353
17	38	64	374
18	40	66	397
19	42	68	420
20	45	70	447
21	47	72	475
22	50	74	510
23	52	76	557
24	55	78	611
25	57	80	691
26	60	82	790
27	64		
28	67		
29	72		
30	76		

Notes on the Geology of Macon County, Missouri.

By W J McGEE, *U. S. Gelogist.*

PREFATORY NOTE.

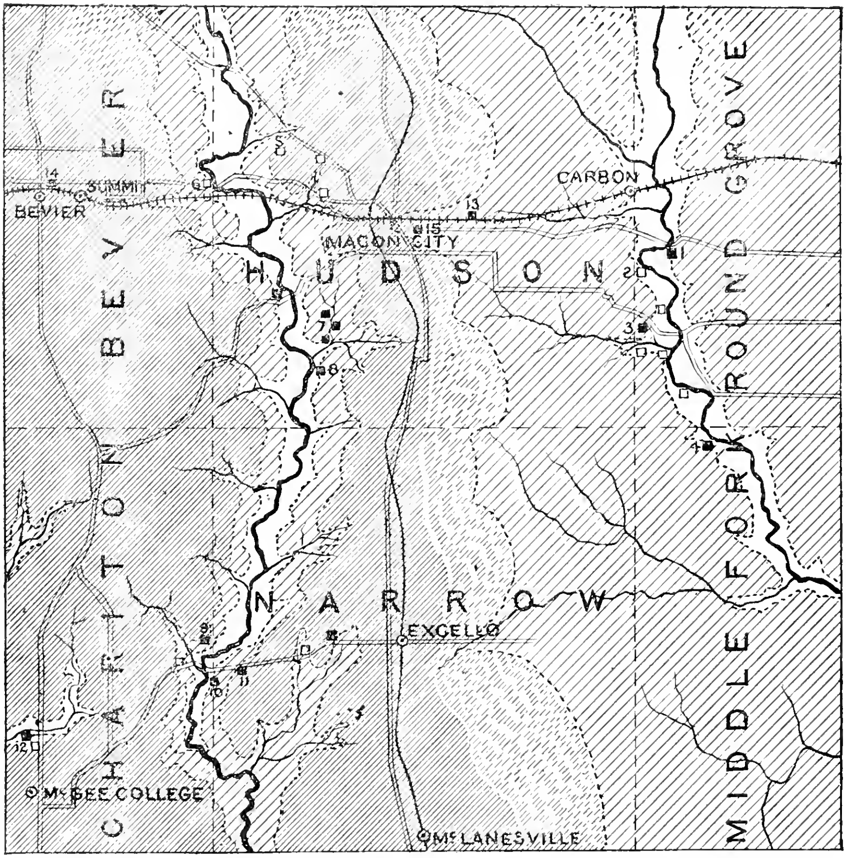
During the summer of 1887 a company was organized in Macon, the county seat of Macon county, Missouri, for the purpose of putting down a prospect-bore to a depth of from 1,500 to 2,500 feet, as the developments might indicate to be wise. The cost of boring was met by subscription among the citizens. Workable coal-seams within limited depth, petroleum or natural gas or both at greater depths, or, failing in all else, artesian water, were the desiderata.

Partly to render the record of the boring valuable to science, and partly to secure the advantages of scientific direction and prognostication, the leading citizens and municipal officers united in requesting the Director of the United States Geological Survey to have made such a study of the local geology as the circumstances appeared to require; and these notes represent the results of the hasty survey inaugurated in response to this request.

The tract specially studied includes the west halves of townships 56 and 57 north, range 13 west, the whole of townships 56 and 57 north, range 14 west, and the east halves of townships 56 and 57 north, range 15 west; or, in civil townships, the west halves of Round Grove and Middle Fork, the whole of Hudson and Narrows, and the east halves of Bevier and Chariton. It is exhibited upon the accompanying rough map, Fig. 1. Most of the exposures (including all of the more important) in this area of 144 square miles were carefully examined.

TOPOGRAPHY.

The "grand divide" between the Missouri and Mississippi rivers extends from north to south through the middle of the tract studied. West of this divide the main drainage is to the southward in a series of nearly parallel streams, flowing in disproportionately large valleys only a few miles apart, into which fall numerous small and short but widely-branching secondaries, generally flowing in narrow, steep-bluffed ravines. East of the divide the drainage is more irregular, the waters commonly gathering into a number of streams tributary to Salt river and flowing in a southeasterly direction; but the first stream east of the divide in Macon county—an important branch of Salt river—



BEVIER COAL CARBON COAL ▪ COAL EXPOSURE ▫ ROCK EXPOSURE

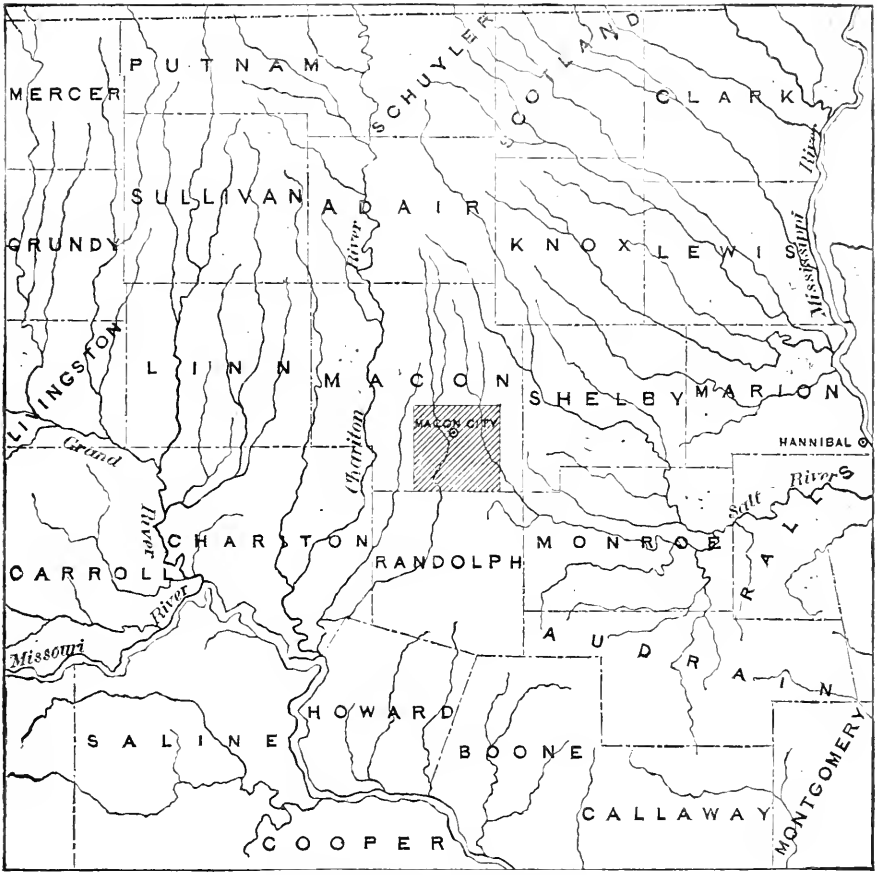
PART OF MACON COUNTY MISSOURI

SHOWING ROCK EXPOSURES AND THE DISTRIBUTION OF COAL SEAMS

Fig. 1.

agrees in behavior with the Missouri drainage rather than the Mississippi, and maintains approximate parallelism therewith half way through, and for 20 miles north of, the tract mapped.

The striking contrast in the direction of drainage on opposite sides of the Missouri-Mississippi watershed is illustrated in the accompanying drainage map, Fig. 2: but the contrast in topo-



AREA MAPPED IN DETAIL IN FIG. 1

HYDROGRAPHY OF NORTH-EASTERN MISSOURI

Fig 2.

graphic configuration and in the value of the relief, and the incongruity in size of stream and valley so strongly marked on the west, could not be shown without more accurate cartography. Except that it marks approximately the boundary between distinctive types of drainage, the "grand divide" is in no respect specially noteworthy or distinguishable on the ground from its scarcely lower analogues on the east and west, beyond Salt river and the East Fork of the Chariton respectively.

As its local designation certainly does not imply, the "grand divide" is simply a broad and remarkably smooth and level plain extending from the immediate bluffs of Salt river to within a mile or two of the East Fork, scalloped and ravined by secondary drainage along its margins, but imperfectly drained interiorly. Its altitude at Macon, where it is somewhat broken by cross-drainage, is about 890 feet, and it inclines southward gently to 866 feet at Excello, and 5 feet less at Jacksonville,* just south of the county line, at both of which points the divide exhibits its normal aspect—i.e. a smooth, monotonous, sensibly horizontal, and imperfectly drained plain.

The divide between the East Fork and the Middle Fork (of the Chariton) is a similar plain, ravined along its margins but level and imperfectly drained within, of almost exactly the same altitude as the principal divide, and, like it, inclining gently southward. The Middle Fork, which bounds it on the west, is however deeper than Salt river, giving this plain the greater average height above its base level; and thus it is more deeply scalloped and more profoundly broken along its margins than the "grand divide." Moreover, it is noteworthy that both Salt river and East Fork generally approach the western sides of their valleys, and that the bluffs on this side are steeper than on the east; and so the eastern margin of the lesser divide is more steeply bluffed than the western margin of the "grand divide."

East of Salt river the surface quickly rises as on the west, and in like manner assumes the form of a level, uniform plain—"Crippen's prairie"—which extends eastward far into Shelby county, and is only slightly incised by the south-flowing Salt river tributaries. This plateau is only a few feet lower than the "grand divide," and slopes so gently southeastward that the inclination is imperceptible, except by comparison of altitudes at widely separated points.

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* Gannett, Dictionary of Altitudes, Bull. U. S. Geol. Survey, vol. i, No. 5, 1884.

The three plateaus are generally prairie, but their crenulate margins and the subordinate valleys of the short tributaries are commonly wooded with oak and other hard-wood trees, frequently of stunted growth; while the valleys of the two rivers by which they are divided generally support a more luxuriant and varied forest growth.

The principal waterways of the tract—Salt river and East Fork—occupy the valleys by which the low plateaus are separated. In many respects these valleys are similar: each is disproportionately large as compared to the stream; each is a broad flat-bottomed trough bounded by steep, even precipitous, bluffs, which commonly assume the forms of spurs and salients separated by narrow, sharply incised ravines, or by the broader valleys of the secondaries; through each the stream flows in a narrow channel 15 or 20 feet deep, which meanders from side to side of the valley in closely recurved loops, as does the Lower Mississippi on a larger scale; each most frequently approaches the western side of the valley, sometimes exposing there low precipices of the stratified rocks; each is lined by alluvium to and generally below the channel bottom; the floor of each is diversified by crescentic ponds and bayous, and also by the deeply cut channels of the secondaries and the runnels extending from the lateral ravines; and each valley bottom has a slope in the direction of stream-flow little greater than the gentle southward slope of the plain in which it has been excavated. The Salt river valley ranges from a quarter to fully three-quarters of a mile in width, averaging perhaps half a mile, and its depth is 50 or 60 feet. The East Fork valley ranges from a quarter of a mile to over a mile wide, averaging perhaps three-quarters of a mile, and its depth probably lies between 90 and 100 feet. Most of the secondaries are small, have high declivity, and flow in narrow V-shaped ravines, frequently bifurcating and forming widely branching dendritic systems sharply incised in the plateaus; but the more important —e g. Long creek and Claybank creek—meander in deep channels through flat-bottomed valleys analogous to those of the rivers.

The leading characteristic of the topography is the combination of level plain and steep slope: a profile transverse to the principal drainage (or indeed in any direction) would exhibit, as its typical feature, horizontal surface-lines suddenly and sharply giving place to slopes as steep as tenaceous clay long exposed to the action of the elements will maintain; and, moreover, such a profile would show that all the uplands have essentially the same altitude, the slight southward inclination of the whole area and the still less inclination east and west from the "grand divide" being inconspicuous. This is imperfectly illustrated in the profile of the accompanying generalized section, Fig. 6 (p. 331). It is indeed manifest that the entire tract represents a single wide-stretching plain in which the effects of erosion are limited to the excavation of the narrow ravines and broader valleys, leaving the greater portion of the surface absolutely untouched.

It is necessary to recognize a distinction among plains, easily caught by the eye and essential in considering their origin, though difficult to express in words. The type of surface commonly comprehended under the term is more or less diversified by elevations and depressions of greater or less vertical measure, regularity, and symmetry; the relative value of the relief (compared to that of contiguous surfaces), as well as the absolute relief, is consciously or unconsciously considered in defining the type, so that what is a hilly tract in a plain country may become a plain in a mountainous country; the mean surface may be concave, convex, or unequal, and the summits and depressions may be independent in their relations to the mean surface; and, as the term is commonly employed, it includes an endless variety of surfaces between which the differences are differences in degree alone. But there is another type of surface, in which there is more or less close approximation to the geometric plane, in which (generally) the mean surface is not sensibly concave, convex, nor unequal, and in which (generally) the summits and depressions bear a constant relation to the mean surface; and this type of plain (exemplified by partially eroded terraces, certain mesas, etc.) is discriminated at a glance, conveys a distinctive impression to the mind, and appears to differ in kind rather than in degree from the other type. The standards or ideals to which these types approximate are elusive, have never been clearly defined, and may be indefinable; but it may be suggested that the first type is represented by any terrestrial surface in which the elements and individual inequalities do not fall into a system of horizontal lines or planes, and which is intuitively referred to an independent mean surface; while the second type appears to be represented by any surface of which a considerable portion naturally falls into one or more horizontal or slightly inclined planes to which the whole surface is instantly and intuitively referred, the inequalities being simultaneously excluded as fortuitous and non-essential. Certainly the distinction between these types of surface, elusive and intangible as it appears on paper, is constantly recognized on the ground by students of terrestrial configuration, and, indeed, lies at the very basis of that branch of geologic science which interprets in terms of geologic history the significant language of topographic forms. Contrasted profile sketches representing them, which are partly ideal though largely actual, are exhibited in Fig. 3.

The interfluvial plateaus of Macon county belong to the latter type of plain; sensibly, they are not simply plains—they are planes.

This strongly individualized topography is not confined to the southeastern quarter of Macon county; it extends over nearly the whole of northeastern Missouri and from 50 to 100 miles into Iowa; and, indeed, essentially the same topographic type is maintained (except in the immediate vicinity of the large rivers) throughout southern Illinois and southwestern Indiana, as well as throughout a considerable area in southern Missouri and northern Kentucky—though its southern limit has not been accurately determined. Over the greater part of this area of probably at least 50,000 square miles the topographic type exemplified in the tract under review, though locally masked by other types, remains characteristic and easily recognizable; the entire area is one of level plains, or rather a single plain, dissected by deeply and sharply incised waterways. This configuration is intimately associated with the superficial deposits of the region; and, although the barely adolescent drainage systems have not yet fully invaded the plains, the drainage, together with the topographic forms developed thereby, represent on a grand scale what is elsewhere*

* Eighth Annual Report of the U. S. Geol. Survey. (In press.)

designated the *autogenetic* type—i.e. the drainage developed upon a level or nearly level plain surface unaffected by localized orogenic movements either antecedent or subsequent to

DISTINCTIVE TYPES OF PLAINS.

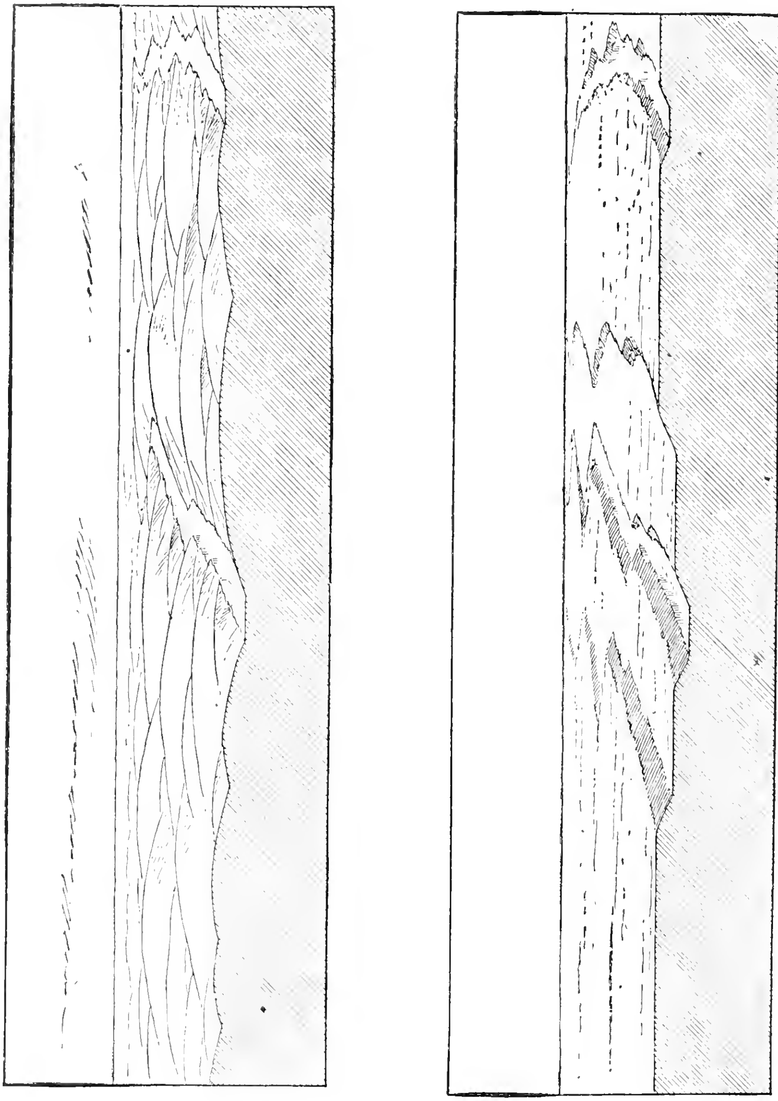

Fig. 3.

the birth of the waterways. Yet the surface of this vast plain could not have been absolutely horizontal when the drainage was first determined, since the parallelism of the streams is confined to comparatively limited tracts, and the direction of drainage in contiguous tracts is not coincident. The remarkable parallelism of the drainage in Missouri, shown in Fig. 2, suggests that on the west side of the "grand divide" there was a decided slope southward, and on the east side nearly as decided a slope southeastward when the waterways originally extended themselves over the surface.

THE SUPERFICIAL DEPOSITS.

Alluvium.—So far as can be determined from exposures in stream channels, the smaller runnels, and the few artificial excavations examined, the valleys of Salt river and East Fork, as well as those of the more important tributaries, are lined with water-laid deposits extending from bluff to bluff, and forming a sensibly level floor, generally wooded densely, and little diversified by abandoned channels or other irregularities. The maximum depth of this deposit was not ascertained; but since the channels were dry (except in the deeper pools) at the time of examination, it was found that the streams have occasionally cut through it and into the drift or the subjacent rocks; and it may be inferred hence that the average depth is little greater than that of the river channels—i.e. some 15 or 20 feet.

The fluvial deposits of the principal streams exhibit two generally distinct phases, the first and more important consisting of massive or rather obscurely laminated brown clay or sand, while the second and subordinate phase is made up of irregularly arranged and heterogeneous loam, sand, and gravel, with occasional intercalated vegetal layers. The brown clay is unlike, but the more heterogeneous deposits are like, the deposits now laid down by the streams; the latter are evidently derived from the adjacent drift and indurated rocks, while the former is as evidently derived from some other source; and, where both occur in the same exposure, the sands and gravels rest upon the clay. The alluvium of the tributaries is generally identical with the superior heterogeneous phase of the deposits as found along the rivers. It is noteworthy that in this as in all other regions of growing autogenetic drainage the smaller streams and ravines are practically destitute of alluvial deposits; each considerable tributary being divisible into three portions, in the first of which the declivity is high and the gathering waters do not deposit their detritus, in the second of which the declivity is less and deposition results from seasonal and non-periodic variation in stage, while in the third the stream approaches base-level and flood-plain deposition prevails.

No terracing was observed in the region, if the occasional rock-shelves and spurs due to the presence of obdurate ledges in the sub-terrane be excepted.

Glacial Deposits.—The entire area, with the exception of the valleys of the rivers and their principal tributaries, is overspread by a mantle of glacial drift which conceals the inequalities of the subjacent surface, and upon which the characteristic topography already described is impressed. The observed thickness of the drift deposits varies from a foot or two to the 30 or 40 feet sometimes exposed in shafts and borings; and the average thickness doubtless approaches and perhaps exceeds the latter figure. Drift materials are occasionally (though rarely) exposed beneath the alluvium in the bottoms of the river channels; but in such situations they are perhaps rearranged.

So far as seen, the drift consists of massive or obscurely stratified, tenacious, and nearly impervious yellow or buff clay, containing rather rare bowlders and pebbles disseminated throughout, but most abundantly below; the pebbles and bowlders constituting about one or two pr. ct. of the mass. Perhaps half of the pebbles and bowlders are erratic, i.e. crystalline rocks from northern Minnesota or still farther northward; while the remainder are local or sub-local—i.e. limestone, sandstone, shale, etc., mainly from the Palæozoic rocks of northern Missouri and Iowa. Many of the bowlders and pebbles, both local and erratic, are beautifully striated and polished. In one case (in an abandoned railway cutting a mile and a half northwest of Macon), a block from the first limestone ledge above the Bevier coal was found to be distinctly striated and to have its angles truncated, though moved but a few feet from its original position. Calcareous nodules, identical with *loess-kindchen*, abound in the drift, especially in the upper portions. They sometimes occur in vertical or horizontal lines, in which they occasionally merge and form nearly continuous sheets several feet in length; and pebbles and bowlders are frequently incrusted and cemented by the calcareous sheets or attached to the nodules. Sand is an unimportant and inconspicuous element in the drift of Macon county.

Although the drift sometimes appears to be vertically homogeneous in exposures however deep, the better sections exhibit certain constant differences between its basal and summital portions: the upper third or half is more or less regularly bedded horizontally, contains fewer and smaller and more irregularly disseminated pebbles than the lower, and exhibits more abundant calcareous concretions and sheets; while the lower portion is generally massive and destitute of regular bedding, and, in short, exhibits throughout the minute but readily recognizable structural and other features which characterize the glacial drift of the upper Mississippi valley generally. The distinction is indeed so strongly marked as to be commonly recognized by the miner and well-digger; yet the two phases invariably intergraduate imperceptibly.

The structural difference between the inferior and superior portions of the otherwise indivisible drift-sheet is evidently genetic: the abundant and well striated local and sub-local bowlders and the characteristic structure and texture of the deposit, the planing of the rock surface (indicated by configuration rather than striation, so far as observed), and the displacement of ledges, all prove that the lower portion of the deposit is the homologue of the till, or unmodified glacial drift, of Iowa, Wisconsin, northern Illinois, and the upper Mississippi valley generally; while the stratification, the assortment of pebbles and other materials, the *loess-kindchen* and other structural characters, and the remarkable horizontality of both bedding and surface-lines over a great area, all indicate strongly that the upper portion is water-laid.

The superior division gives origin to soil and sub-soil of peculiar tenacity and intractability, evidently by reason of the finely comminuted condition of its materials and the presence of a small percentage of unoxidized rock débris, and the consequent tendency to pack closely and undergo partial cementation. Unless carefully and judiciously tilled, the soil is prone to "drown" in spring and "bake" in summer, especially on the imperfectly drained plains forming the uplands; but these characteristics are lost in a measure along slopes where the natural drainage is superior and the subsoil is leached to a considerable depth by more freely percolating waters. It is unquestionably to this peculiarity of the soil that the confinement of forests to slopes and valleys is due; and the superior porosity and fertility of the naturally drained soils indicates that the "sour" soils of the plains might be gradually reclaimed by means of persistent and thorough under-drainage.

It should be added that the peculiar phase of the drift represented in the upper portions of the Macon county sections may be observed throughout nearly the whole of the area of fifty thousand square miles or more characterized by the peculiar topography already described, though it is frequently overlaid by loess or other superimposed deposits; and it seems probable that the upper portion of the drift throughout this whole region was laid down in a continuous body of water by whose waves the great plains were fashioned. and that the characteristic autogenetic drainage of these plains was developed as the waters receded.

The Relations of the Deposits.—Neither glacial drift nor alluvium were traced southward beyond the limits of Macon county, nor were they directly correlated with the "second bottom," the Port Hudson, the loess, or other deposits of central and south-eastern Missouri. But the former was traced northward into a region already carefully studied in southern Iowa, in which the superior phase maintains its characters and has received various local designations commonly expressive of its character as a soil —"gumbo," "hard-pan," "white clay," "push-land," "crawfish flats," etc.,—and in which, as in Missouri, the upper portion graduates imperceptibly downward into unmodified glacial drift.* Here, however, the drift is frequently overlaid by loess, a forest bed being sometimes intercalated, and somewhat farther northward another drift-sheet comes in at the base of the loess and above the forest bed: and the loess frequently graduates imperceptibly downward into the newer drift, much as the laminated portion of the Macon county drift-sheet graduates into its lower portion. The full sequence of deposits is therefore:

* *Trans. Iowa State Hort. Soc.* for 1881, vol. 16, 227 40.

1. LOESS (frequently graduating into but sometimes resting upon—)
2. UPPER TILL (disappearing southward sooner than the loess);
3. FOREST BED (absent south of the loess margin);
4. GUMBO (or water-laid upper portion of the lower till);
5. LOWER TILL.

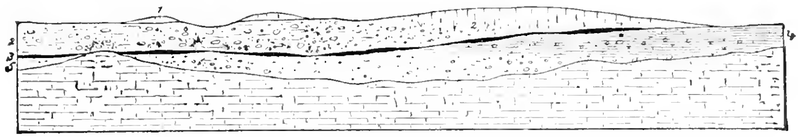

Fig. 4

The relation is represented graphically in the greatly generalized section forming Fig. 4. The terminal moraines, so well described by Chamberlin and others, are either confined to the second member of this series and do not extend to its extreme southern margin, or (more probably) to a third epoch of cold not represented in the glacial deposits of Missouri; and the last two members only are found in Macon Co.

Recent work in the Middle Atlantic slope has shown that the Quaternary period, during which the above series of deposits was laid down, comprised two widely separated epochs of cold, the earlier of which was by far the longer and was accompanied by considerable depression of the land and submergence of low-lying areas;* and these conclusions are in harmony with the phenomena of southern Iowa and northern Missouri. It would appear that during the earlier epoch of cold the Quaternary ice-sheet extended into Missouri about to the Missouri river, that before its recession the land along its margin was submerged, and that the currents of the expanded Gulf or an inland lake modified and arranged the upper portion of the drift-sheet, while its waves fashioned the extensive plain of autogenetic topography stretching from Indiana to western Missouri; and it would also appear that during the second epoch of cold the ice-flow stopped a hundred or a hundred and fifty miles short of its earlier limit, and was without effect in the tract under review unless the disproportionately large valleys were then excavated and the homogeneous alluvium—the apparent homologue of the "second bottoms"—was accumulated within them as the ice-formed rivers subsided.

* Eighth Annual Report U. S. Geol. Survey (in press).

The early Quatenary submergence thus chronologized has already been recognized in central Missouri by Dr. J. W. Spencer.*

THE INDURATED ROCKS.

Only the more important of the exposures observed are noted in the following pages. The sections are located upon the map, Fig. 1, and most of them are represented graphically in Fig. 5.

Exposures on Salt River. — The best exposure observed on the river is at Bengee's coal mine, a mile south of the Hann. & St. Jos. railway.

1. Bengee Section.

		Feet.
1.	Compact light gray limestone with conchoidal fracture, magnesian in spots and bands; no identifiable fossils but abundant obscure shell impressions	$3\frac{1}{2}$
2.	Thinly laminated bright black fissile shale, containing large ovoid nodules	5
3.	Coal, about	2
4.	Under clay passing into a slope with blue loam at base, about	13
5.	Impure concretionary dolomite in a discontinuous ledge	1
6.	Argillaceous shale, yellow above and blue below, weathering into tenacious clay	$4\frac{1}{2}$
7.	Discontinuous bed of friable dolomite	$\frac{1}{4}$
8.	Argillaceous shale, incoherent above but firm below	5
9.	Massive compact limestone, containing abundant *Producti* (including *P. æquicostatus*), forming a single continuous ledge	1
10.	Blue argillaceous shale, quickly weathering into clay, abounding in detached valves of *Chonetes mesoloba*	3
		$38\frac{1}{4}$

The section extends from near the summit of a low bluff to the bottom of the river channel. In addition to affording one of the best series of strata observed within the area, it is of interest in that it exhibits what appears to be a slight local misplacement in the lower strata of the section: the *Productus*-bearing limestone and the underlying shales being at one point thrown upward perhaps three feet above the general level in a sharp-crested anticlinal, quickly fading out in both directions. The flexure, if such it be, appears to be lost in the superjacent shales, and was not observed to affect the coal seam. It is claimed that the coal here is 3 feet thick, but the above estimate — two feet — cannot be far wrong, though the seam was not measured.

* "Sand-bowlders in the Drift, or subaqueous Origin of the Drift in Central Missouri," *Am. Naturalist*, vol. xxi., 1887, 917-21.

The next noteworthy exposure occurs in the river channel a mile and a half south of Carbon; and, in addition to the strata laid bare by the river, large ovoid nodules, such as come from the black shale above the coal, were scattered about, while, near by, limestone resembling that above the coal at the Bengee and Sherman workings crops out in the steep bluff some 25 or 30 feet above the *Productus* limestone. The combined exposures are as follows:

2. Salt River Section.

	Feet.
1. Massive, heavy-bedded limestone, magnesian in spots	3
2. Slope, with ovoid nodules exposed, about	27
3. Slightly arenaceous shale or clay	2
4. Firm massive limestone in one heavy and two discontinuous thin ledges, containing abundant traces of brachiopods, and yielding a fine specimen of *Productus æquicostatus*	2½
5. Argillaceous shale weathering into clay with abundant detached valves of *Chonetes mesoloba*	4
6. Slope to bottom of channel	3
	41½

Perhaps a mile farther down the river, and in the next westerly bend, a similar exposure was observed in the river channel as follows:

	Feet.
1. Slope, passing down into arenaceous shale with "coal-blossom"	5
2. *Productus*-bearing limestone in a heavy ledge with one or two thinner and discontinuous ledges	2
3. Bluish argillaceous shale weathering into clay, with abundant shells of *Chonetes mesoloba*	3
4. Slope to bottom of channel	3
	13

The Sherman coal-working is on a little stream falling into Long branch, half or three-quarters of a mile above its confluence with Salt river. There are several openings and a few natural exposures, which, combined, afford an excellent section.

3. Sherman Section.

	Feet.
1. Compact massive limestone, sometimes magnesian in spots and bands, discontinuously bedded; without well preserved fossils, but with many traces of shells	4½
2. Calcareo-argillaceous shale (sometimes absent)	1

3.	Thinly and regularly laminated black fissile shale, containing ovoid nodules	5
4.	Coal	2
5.	Fire-clay	4
		16½

The workable coal is barely 2 feet—generally running from 22 to 23 inches. The base of this section is 2 or 3 feet above the bottom of the ravine, and perhaps 25 feet above the bottom of the river-channel.

A number of coincident exposures were observed on Long branch within a mile from its mouth; and a mile farther southward there is an exposure of *Productus*-bearing limestone in the bottom of the river channel, the associated beds being invisible.

The next important exposure is at Hunt's coal-working, some 2 miles below the mouth of Long branch. The following section is made up of a natural exposure in the stream channel, which there hugs the western side of the valley, and the artificial exposure of the working a few yards distant. The lowest member was only seen in an excavation in the channel bottom.

4. Hunt Section.

		Feet.
1.	Slope, with a few fragments of limestone	5
2.	Bright black fissile shale, with ovoid nodules	4
3.	Coal, about	2
4.	Fire-clay passing down into slope	12
5.	Calcareo-arenaceous shale, locally lithified	10
6.	Slope	2
7.	Irregularly bedded knobby limestone with abundant shells of *Productus*, etc.	2
8.	Incoherent argillaceous shale	2
		39

The absence of the limestone stratum commonly overlying the black shale is remarkable, since it ordinarily forms the verge of the escarpment in which this coal-seam occurs and in which the openings are located.

The coal-workings from which Carbon was named are now abandoned, and the strata there are no longer well exposed.

Exposures on East Fork.—The most northerly outcrop observed is on the land of W. H. Payson, Esq., some 2½ miles northwest of Macon, in a ravine perhaps a quarter of a mile east of and 40 or 50 ft. above East Fork. It is supplemented by coincident exposures at about the same altitude in an abandoned railway cutting a mile and a half northwest, and in the Bevier road a mile west, of Macon.

5. Payson Section.

		Feet.
1.	Regularly bedded slightly magnesian limestone, no fossils observed, about	2½
2.	Calcareo-arenaceous shale, about	3
3.	Arenaceous shale, sometimes locally lithified into moderately firm sandstone, about	6
		11½

The next section observed is in the channel and west bluff of East Fork, just above the bridge on the Bevier road. It is much obscured by talus, but the various portions exposed at different points were readily combined.

6. Bevier Bridge Section.

		Feet.
1.	Compact limestone, generally pure but sometimes slightly magnesian, containing no good fossils but occasional traces of shells. In one or two heavy ledges	3
2.	Thinly laminated black fissile shale	3
3.	Slope, about	15
4.	Irregularly bedded knobby limestone with abundant *Producti*, etc.	2
5.	Slope to bottom of river channel	1
		24

In descending the river an exposure was observed at the bridge on the McGee College road which supplements and corroborates the Patton creek section. It is as follows:

		Feet.
1.	Limestone, heavy-bedded and massive, bluish-gray, generally pure or slightly argillaceous but sometimes magnesian, with conchoidal fracture; containing no well preserved fossils but many obscure markings	3
2.	Bright, jet-black shale, thinly and evenly laminated, with nodular concretions, darkest below	5
3.	Coal	1½
4.	Fire-clay, bluish-gray, tenacious	3
5.	Slope to clay-bed of creek, about	5
		17½

The next noteworthy exposures are on Patton creek, from half a mile to a mile and a half above its confluence with East Fork. A dozen or more exposures were combined to form the section.

7. Patton Creek Section.

		Feet.
1.	Limestone, generally light gray but sometimes bluish, commonly pure but occasionally argillaceous or magnesian, heavy-bedded, with shaly partings, rare fossil impressions	2 to 5
2.	Glossy black thinly laminated shale with ovid nodules	8
3.	Coal	$1\frac{1}{2}$
4.	"Soapstone" (fire-clay)	5
		$19\frac{1}{2}$

The coal here was roughly estimated to be 20 feet above the bottom of the channel of East Fork.

About the mouth of Patton creek the exposures in the bluffs of both creek and river become more extensive. This locality was examined nearly thirty years ago* by Prof. G. C. Broadhead, then Assistant State Geologist, and an important section is recorded in his report.† A part of this section, which was observed "at Reese's coal-bed," was re-examined and verified, though the 13-inch coal-seam is not now visible. The section is as follows:

8. Broadhead Section.

1.	Limestone	1′
2.	Bituminous shale	15″
3.	Bituminous coal	13″
4.	Slope, showing clays and shales	6 to 10
5.	Drab inclining to olive argiliaceous shales	5′
6.	Bluish-drab limestone, weathering to brownish	3′
7.	Bluff shales or clay	6″
8.	Shales; olive at top, dark blue at bottom	11″
9.	Bituminous shales, containing at the lower part a bed of indurated pyritiferous shales containing many fossils, viz.: *Productus muricatus*, *P. æquicostatus*, *Machrocheilus*, *Selenomya*. *Orbiculoidea*, *Chonetes Smithi*, *Teniopteris*	4′
10.	Bituminous coal	22″
11.	Bluish fire-clay	

There is an exposure on the McGee College-Excello road in the bluff half a mile west of East Fork, from which the following sequence is easily made out, although thicknesses are indeterminate:

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* Within the period from 1857 to 1861. Vide *Trans. St. Louis Acad. Sci.*, iv., No. 4, 1886, p. 557.

† Rep. Geol. Survey Mo., 1855-'71, by Broadhead, Meek, and Shumard; 1873, p. 81.

1. Sandstone and arenaceous shales.
2. Coal and coaly débris.
3. Brown limestone.
4. White limestone.

The same succession may be observed in adjacent hills, where, indeed, these firm ledges and the soft associated shales give character to the topography. The stratigraphy here is significant in that it supplements and connects the Claybank creek and Mayfield sections.

A good section is exhibited in the bluffs, in the mine, and in a freshly excavated well near by, at the Mayfield coal-working 3 miles west of Excello. The sequence is as follows:

9. Mayfield Section.

	Feet.
1. Brittle clinking limestone with splintery fracture, no fossils	3
2. Slope	10
3. Moderately firm sandstone, about	4
4. Slope	4
5. Arenaceous shale or clay	1
6. Coal	$5\frac{1}{2}$
7. Under clay and slope, about	5
8. White limestone, containing no fossils but abundant crystals of calcite, generally pure but sometimes shaly	4
9. Slope	13
10. Blue clay (in well)	
	$49\frac{1}{2}$

The base of this section is estimated to be 40 feet above the bottom of the East Fork channel; but the corresponding strata in the road toward McGee College appear to be 10 or 20 feet higher.

Another instructive exposure occurs just below the bridge over East Fork on the Excello road. It appears in the channel and east bluff of the river, which the stream there approaches. It is as follows:

10. Excello Bridge Section.

	Feet.
1. Drift	10
2. Heavy-bedded limestone in discontinuous ledges, generally pure but sometimes magnesian	4
3. Thinly and smoothly laminated jet-black shale, with ovoid nodules	5

4. Coal	$1\frac{1}{2}$
5. Light blue fire-clay, extending to bottom of channel	3
	$23\frac{1}{2}$

Three-quarters of a mile east of the river there is a series of exposures in a ravine and in road-side gullies, which combine to form the following section:

11. Excello Road Section.

	Feet.
1. Limestone	2
2. Slope	3
3. Coal	$1\frac{1}{2}$
4. Clay and Slope, about	8
5. Hard clinking limestone with splintery fracture, about	2
6. Slope	10
7. Sandstone, generally friable but sometimes firm	7
8. Arenaceous clay (sometimes absent)	1
9. Coal, exposed	4
	$38\frac{1}{2}$

The heavy coal-seam at this point was estimated at 50 feet above the channel at East Fork.

In the creek crossing this road about a mile and a half west of Excello there are several exposures from which a closely coincident section may be constructed. It extends from the clinking limestone of the above section to the brown and white limestones and the subjacent shales seen on Claybank creek; and in a hill just east of the Emerson coal-working, a mile west of Excello, there are exposures showing that a heavy bed of fire-clay occurs below, and the heavy coal-seam above. a conspicuous bed of limestone, as is the case on Claybank creek. The coal-seam at this working is about $4\frac{1}{2}$ feet thick.

Exposures on Claybank Creek.—There are several exposures in the road from Bevier to McGee College (or College Mound) in the vicinity of Claybank creek; and there are additional exposures along the south side of the creek for half a mile west from the road. Combined, these constitute an excellent section:

12. Claybank Creek Section.

	Feet.
1. Heavy-bedded sandstone, sometimes incoherent	4
2. Arenaceous shale or sandy clay	1

3.	Coal	5
4.	Clay and slope, about	5
5.	Brown ferruginous dolomite with peculiar vertical markings probably formed by a coral now completely dissolved	2
6.	Light gray heavy-bedded limestone with conchoidal fracture, sometimes argillaceous with shaly partings, sometimes dolomitic in spots and bands, with no good fossils but many obscure traces of shells and corals	3
7.	Light blue shale rapidly breaking down into clay with abundant detached valves of *Chonetes mesoloba*	11
		31

The section extends to the bottom of the channel of Claybank creek, immediately below the bridge. The coal is best exposed in two workings, an eighth and a quarter of a mile farther west respectively; but it is also seen in its proper place in the road. It is noteworthy that in the half or three-quarters of a mile of more or less imperfect exposures combined in this section there is a westward inclination of not less than 30 or 40 feet.

Exposures on the Hann. & St. Jos. Railway.—Some three-quarters of a mile east of Macon there is an abandoned coal-working, near the lower brick-yard, in which the coal appears to have been obtained only a few feet below the surface; and about a quarter of a mile farther east, and at a somewhat lower level, a few ledges of rock dipping gently eastward are exposed in the dry channel of the stream below the railroad bridge. The strata appear to fall into the following arrangement:

13. Lower Brick-yard Section.

		Feet.
1.	Gray shale or clay	2
2.	Slope	1½
3.	Evenly-bedded limestone	1½
4.	Hiatus, probably about	2
5.	Coal	?
		7

At Bevier the coal-workings are of great extent and importance, yet little rock is exposed. In the channel of the creek near the depot there appears a rather friable sandstone, frequently nodular and irregular, sometimes cavernous and intersected by peculiar shrinkage crevices recalling the interior structure of *loess-kindchen*, though the scale is much larger; and the cement, where the lithifaction is perfect, appears to be at least in part calcareous. This sandstone is overlaid, and appears also to be underlaid, by arenaceous shale. Only one of the coal-workings was carefully examined. The coal (which is quite uniform) averages 4 feet 5 inches in thickness, and was found to be underlaid by dark shale or clay and covered commonly by arenaceous shale, sometimes lithified, but occasionally by argillaceous shale. The seam is sensibly horizontal, and lies perhaps 50 feet below the railroad grade. It is sometimes affected by "difficulties," comprising both "rolls" and "horsebacks"; and more rarely it is interrupted by clay-partings, which are usually slickensided. Consistent and unquestionably reliable information, derived from different individuals at this point, indicates that at Summit and elsewhere there is a thin (about 15-inch) coal-seam some 25 or 28 feet above the heavy seam, and that a few feet below the latter a notable ledge of limestone occurs. The various data fall into the following relation:

14. Bevier Section.

	Feet.
1. Drift, variable, but in one case	20
2. Hiatus, say	5
3. Coal	$1\frac{1}{4}$
4. Hiatus, say	7
5. Arenaceous shale, sometimes lithified, not less than	20
6. Argillaceous or argillo-arinaceous shale	1
7. Coal	$4\frac{1}{2}$
8. Under-clay, etc., about	5
9. Compact limestone, say	5
	$68\frac{3}{4}$

The Boring in Macon.—The prospect bore is located in the southeastern part of the city in a ravine some 30 feet deep, where the drift was found to be 36 feet in thickness. An ordinary plunge drill was used. The diameter of the bore is 13 inches in the drift and 8 inches in the rock to 320 feet from the surface, where a strong flow of water was encountered and the diameter was reduced to 5 inches. Samples were taken by means of the "sand pump" at frequent intervals, particularly when change in character of material was indicated by the behavior of the drill; and special care was exercised in taking samples and in determining thicknesses of strata when the borings indicated the proxiximity of coal-seams. The samples were collected and preserved by the well-driller and one or more representatives of the citizens' committee acting in conjunction with him; and the depth from which each was taken was indicated upon the box in which it was preserved. In the following notes the depths are transcribed from this record. The specimens were personally examined; and the notes represent the inferences then made as to the character of the strata from which specimens were derived rather than accurate descriptions of the specimens themselves.

15. Macon Section.

	Thickness of Stratum.	Total Depth.
1. Drift (no specimens preserved)	36′	36′
2. Blue calcareo-argillaceous shale breaking down into clay with a few firm fragments	9′	45′
3. Hard brittle blue limestone with conchoidal fracture, mixed with shaly débris and mud evidently derived from the breaking up of shale	1′	46′
4. Black shale breaking up into graphite-like mud	2′	48′
5. Coal, with a few fragments of shale	1′ 1″	49′ 1″
6. Blue shale or clay containing a little grit, breaking down into mud, with a few shaly scales	5′ 11″	55′
7. Tenacious blue clay with a few shaly flakes and a trace of grit	10′	65″
8. Gray calcareous shale with a few fragments of limestone, of which some are veined with calcite and exhibit conchoidal fracture	5′	70′
9. Black shale, the larger fragments of which exhibit parallel lamination	3 2½″	73 2½
10. Coal	1 9½	75
11. Tenacious blue clay containing a little gritty matter	33′ 8″	108′ 8″
12. Black graphite-like clay with a few bits of gray clay, the whole containing a little gritty matter and scales of shale	17′ 4″	126′
13. Dark gray or black clay evidently derived from slightly calcareous shale containing fragments of dark blue limestone	6″	126′ 6″
14. Firm black carbonaceous shale	1′ 9″	128′ 3″
15. Slightly calcareous gray clay with abundant shaly scales	8′ 3″	136′ 6″
16. Calcareous gray clay with shaly scales	18′ 6″	155′
17. Slightly calcareous dark gray shale	30′	185′

	Thickness of Stratum.	Total Depth.
18. Light gray limestone, pure, probably massive or thick-bedded, with conchoidal fracture	28′	213′
19. Light gray sub-crystalline limestone intermixed with dark gray shale	7′	220′
20. Light gray slightly calcareous shale and clay	53′	273′
21. Dark gray slightly calcareous clay	3′	276′
22. Calcareous gray shale	5′ 6″	281′ 6″
23. Light gray cherty limestone	5′	286′ 6″
24. Light gray limestone, dark gray calcareous shale, and chert	3′ 6″	290′
25. Light gray cherty limestone	30′	320′
26. Bluish gray calcareous shale	5′	325′
27. Light gray cherty limestone and dark gray calcareous shale	10′ 6″	335′ 6″
28. Light gray and dark gray nodular calcareous shale	39′6	375′
29. Light gray siliceous limestone and chert	21′	396
30. Light buff pulverulent rock containing beautiful crystals of carbonate of lime and carbonate of iron, and leaving a considerable residue (probably siliceous and magnesian) after digestion in acid	14′	410′
31. Dark gray arenaceous shale, light gray calcareous shale, and crystals of calcite	72′	482′
32. Light gray arenaceous and calcareous shale with light buff powder like 30	27′	509′
33. Blue sparry limestone with fossil markings	23′	532′
34. Shaly blue limestone	43′	575′
35. Light gray and dark blue shaly limestone	60′	635′
36. Blue limestone	17′	652′
37. Light blue sparry limestone	112′	764′
38. Light blue cherty and arenaceous limestone	36′	800′
39. Gray sparry limestone and fine fissile blue shale	95′	895′
40. Massive blue shale or indurated clay	100′	995′
41. Fine ca'careous sand	5′	1000′

The General Section.—It should be mentioned that while only the more important of the exposures observed in Macon county are recorded in the foregoing paragraphs, a large number of outcrops of single ledges or beds were examined and found to afford material aid in tracing and correlating the strata; and it should be added that many strata—e.g. the clinking limestone, the brown dolomite of Claybank creek, the *Productus* limestone, the nodular black shale, etc.—exhibit numberless minute but persistent and easily recognizable diagnostic features by which they can be readily discriminated wherever found.

In following the exposures down Salt river from the Hann. & St. Jos. railway to Hunt's coal-worki g it is found that the strata have a southward inclination somewhat greater than the slope of the river: for not only does an identical and unmistakable rock-sequence—semi-dolomitic limestone, nodular black shale, coal, and fire-clay, of constant thickness and uniform order, and uniformly related to an underlying fossiliferous limestone of peculiar character—appear at progressively decreasing heights above the channel bottom, but the obscure yet unmistakable rock-shelf formed in the bluffs by the limestone declines perceptibly with respect to the river. The strata on East Fork have in like manner a southward dip slightly greater than the river slope: for not only does a distinctive horizon 18 feet above the channel bottom at the Bevier bridge descend to the extreme bottom of the channel at the Excello bridge, but the conspicuous sandstone beds sink from mid-height of the bluffs in the latitude of Bevier and Macon to only a quarter or third of the way up the slightly higher bluffs in the latitude of Excello.

Moreover, since the rock sequence exposed on Salt river is duplicated so exactly on the East Fork as to leave no doubt of its identity (the chief difference being a slight thinning of a coal seam), and since the latter valley is some 35 or 40 feet deeper than the former, it is evident that the strata have a dip westward; and this dip appears to be about equal to the southward inclination. The true inclination is therefore southwesterly. The mean rate may be roughly estimated at about 7 or 8 feet per mile; and the local inequalities are unimportant. This uniformity in dip facilitates correlation of the detached sections.

On seeking to so combine the various exposures as to form a general section exhibiting the succession of strata in the region, they fall at once into three groups: The first of these includes the four Salt river sections, the Bevier bridge section, the Patton creek section, and the Excello bridge section; the second includes the Claybank creek, Mayfield, Excello road, Bevier, and Payson sections; while the third includes the Broadhead section, the Lower Brick-yard section, and the Macon boring. The first two of the groups correlate readily among themselves; while of the third group one section was personally examined only in part, another is isolated, and the last is necessarily less satisfactory than an outcrop section, and the group thus becomes of secondary importance.

The hiatus between the first and second groups, measured between the 5-foot coal seam and the seam so conspicuous on Salt river, was estimated to be 45 ft. at the Payson and Bevier bridge sections, 50 feet at the Excello road and Excello Bridge sections, 50 feet at the exposures northwest of Macon (also referred to Bevier bridge), 40 feet at the Mayfield and Excello bridge sections, and 60 feet between the Excello bridge section and the exposure on the road toward McGee College. It is believed that all of these estimates are within 20 or 25 per cent. of the truth. The mean is about 50 feet. This hiatus is in part filled by the Broadhead section, a portion of which was verified and the 22-inch coal seam noted near its centre correlated with the 18-inch seam of Patton creek. On adding the upper part of this section to the Excello bridge sequence, and juxtaposing with that of Claybank creek, the hiatus appears to be nearly filled; but, since none of the strata can be certainly correlated, there is some uncertainty as to the relation; and the exact thickness of the missing strata cannot be ascertained.

On juxtaposing the Broadhead section and the Macon boring, the relations of the strata penetrated by the prospect drill become at once apparent. It is true that the limestone above the lowest coal becomes "calcareous shale" in the boring record, that the vertical interval between the coal seams in the exposure appears too small unless the larger estimate of the "slope" (number 4 of the section) be adopted, and that there are a few other incongruities; but, when the uncertainty inseparable from the methods of determining the stratigraphy in the one case and the thickness in the other is considered, this discrepance becomes insignificant. The Lower Brick-yard section also falls into a position consistent at once with the stratigraphy and with relative altitudes; but the imperfection of the section is such that the coincidence can scarcely be regarded as corroborative of the accuracy of the correlation.

Accordingly the several exposures may safely be combined as

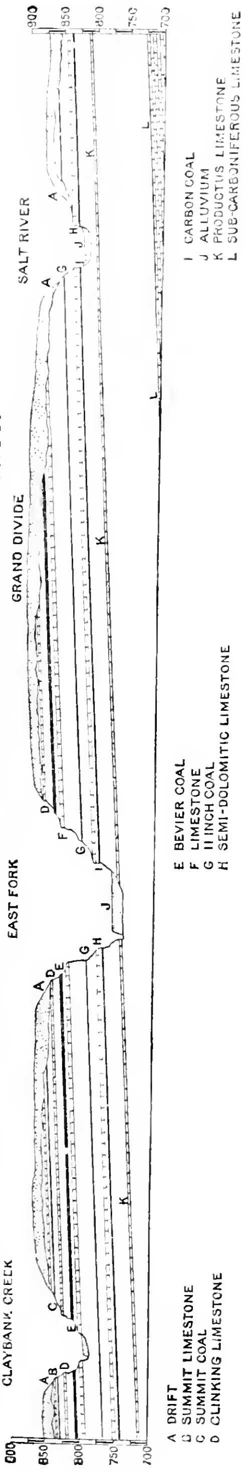

Fig. 6. GENERAL SECTION THROUGH MACON COUNTY.

in the accompanying diagram, Fig. 6; and the general section of the Lower Coal Measures of Macon county, Missouri, from the limestone above the Summit coal to the Sub-carboniferous limestone—a section measuring not less than 210 and certainly not more than 225 feet—may be formulated as follows:

Conspectus of Macon County Strata.

		ft.	in.
1.	Upper limestone	2′	
2.	Shale or clay (slope in sec. 11)	3	
3.	Summit coal	1	6″
4.	Shale or clay (slope in sec. 11)	8	
5.	Clinking limestone	2	6
6.	Arenaceous shale or sandstone	17	
7.	Bevier coal	5	
8.	Fire-clay and shale	5	
9.	Brown dolomite	2	
10.	White limestone	3	
11.	Upper *Chonetes* shale or clay	13	
12.	Hiatus	5	
13.	Clay or shale	3	6
14.	Limestone	1	3
15.	Black shale	2	
16.	Eleven-inch coal		11
17.	Shales, clay, etc.	16	
18.	Semi-magnesian limestone	4	6
19.	Glossy black shale with ovoid nodules	4	6
20.	Carbon coal	2	
21.	Fire-clay	5	
22.	Shales and clays	8	
23.	Impure limestone	1	6
24.	Shales and clays	10	
25.	*Productus* limestone	2	
26.	Lower *Chonetes* shale	4	
	Total observed thickness (including hiatus)	132	2
27.	Predominantly carbonaceous shales, etc. (bottom of 11, with 12–14 of sec. 15)	23	
28.	Calcareo-argillaceous shales (15–17 of sec. 15)	56	9
	Sub-Carboniferous limestone. Total from boring record alone	79	9
	Aggregate	212	

The relations of the more important members of this series both among themselves and to the surface are shown graphically in the general section through the tract surveyed forming Fig. 6.

The relations of the series as a whole to the subjacent formations are roughly indicated by the boring record. While it is evident from the record, and still more from the borings themselves, that samples were not taken with sufficient frequency to give an accurate sequence, inspection shows that borings brought up from beneath the summit of the first heavy limestone fall naturally into nine groups, viz.:

Group.	Petrographic Character.	Boring Record No.	Thickness.
1	Limestones	18-19	35′
2	Somewhat calcareous shales	20-22	62′
3	Cherty limestones and associated shales	23-27	54′
4	Nodular calcareous shales	28	40′
5	Silicious limestones, calcareous shales, etc., of heterogeneous character	29-33	157′
6	Shaly and non-silicious limestones	34-37	232′
7	Cherty limestones passing into shales	38-39	131′
8	Shales or indurated clays	40	100′
9	Sandstone	41	

Taxonomy.—The time at disposal did not permit, and the exigencies of the investigation did not require, sufficiently extended collection of fossils or of stratigraphic data to warrant correlation of the Macon county series of deposits with those of other regions. It was found, indeed, that the fossils are of little value in identifying the several beds in which they occur, partly no doubt because they were not collected and studied with sufficient care, but partly because the same genera and species occur at various horizons wherever the strata are of like composition. Thus *Chonetes mesoloba** is found in equal abundance in two beds separated by a vertical interval of over 70 feet in Macon county, and, according to White, ranges "through the whole series of strata of the Carboniferous period in Illinois, Missouri, and Iowa";† while *Productus æquicostatus*, whose type comes from

* Identified by Mr. C. D. Walcott, Palæontologist U. S. Geological Survey.

† Rep. Geog. and Geol. Expl. and Surveys W. of the 100th Mer., iv. pt. 1, 1875, 123.

the Coal Measures far above the Macon county series,* together with its associates, occur in nearly equal abundance in the two limestones below the Carbon coal, and more rarely in all the limestones of the series. Fortunately the occasion for examining the taxonomic relations of the naturally exposed strata does not exist, since they have been acceptably referred by the widely-known official geologists of the State, Professors Swallow and Broadhead to the Lower Coal Measures, as defined by the former† and applied in Macon county by the latter.‡ The "Ferruginous Sandstone" of these authors was not recognized either in outcrops or in the boring records; and the Coal Measures may be regarded as terminating above the 35-foot limestone forming Nos. 18 and 19 of the record.

The data afforded by the borings are too meagre to indicate decisively the relations of the several strata penetrated; but, on comparing the materials and thicknesses of the groups into which they fall with the general sections developed by the State surveys of Missouri, Illinois, and Iowa (a sort of composite of which was prepared for use in prognosticating the results of the boring), it becomes apparent that the first group, with perhaps some of the subjacent shales, simulates the St. Louis; that the combined second and third, with perhaps part of the fourth, correspond closely with the Keokuk; that the fifth and the remaining part of the fourth occupy the place and exhibit the characters of the Burlington; that the sixth is allied to the Kinderhook; that the seventh agrees fairly well with the Niagara; and that the eighth closely approaches the Hudson River, to which the ninth may also belong. Accordingly, the various strata exposed naturally and penetrated by the drill in Macon county may be tentatively classified as in the following table, in which there is also introduced, chiefly to indicate the possible extent of the personal equation in influencing the classification, the section predicted when the drill was in the 35-foot limestone.

* 1st & 3d Rep. Gen'l Survey Mo., Swallow, 1855, pt. ii. 201, pl. C., fig. 10.

† *Op. cit.*, 89–91.

‡ Rep. Geol. Survey of Mo., 1855–71, by Broadhead, Meek, and Shumard, 1873, 74–92; Atlas acc. Rep. on Iron Ores and Coal Fields, 1873, pl. v.

Section of Northern Missouri Strata.

	Group.	Petrographic Character.	Boring Record No.	Thickness.	Predicted thickness.
	Lower Coal	— Shales, clay beds, limestones, coal seams, etc.	2-17	215′	215′
Carboniferous.	St. Louis	1. Limestones	18–19	35	60
	Keokuk	2. Somewhat calcareous shales	20–22	62	100
		3. Cherty limestones and associated shales	23–27	54	
	Burlington	4. Nodular calcareous shales	28	40	225
		5. Silicious limestones, calcareous shales, etc.	29–33	157	
	Kinderhook	6. Shaly and non-siliceous limestones	34–37	232	175
Devonian	Hamilton	(*Not recognized.*)			75
Silurian	Niagara	7. Cherty limestones passing into shales	38–39	131	225
	Hudson River	8. Shales or indurated clays	40	100	200
		9. Sandstone	41		
	Trenton	(*Not reached.*)			450
	St. Peter	" "		......	50
		Total thickness		1026	1775
		Discrepance (assuming bore to half penetrate Hudson River)		140 feet.	

THE COAL FIELDS.

As shown in the accompanying map and generalized section (Figs. 1 and 6), as well as in the foregoing conspectus, there are in southeastern Macon county four coal seams, viz : (1) the Summit coal, (2) the Bevier coal, (3) the 11-inch coal, and (4) the Carbon coal.

The Summit coal is not known to exceed 16 or 18 inches in thickness in the tract studied; nor is it known to have been worked. Its field corresponds roughly with that of the Bevier coal save that it has been further reduced by erosion; and its periphery accordingly falls from a few yards to a mile within the margin of the latter. It may perhaps be economically mined in a small way by open workings; but its extraction would probably be found unprofitable under existing conditions.

As shown by the detailed sections represented in Fig. 4, the Bevier coal ranges in thickness from an average of 4 feet 5 inches at Bevier to nearly 5 feet on Claybank creek, and about 5½ feet at the Mayfield working; and these measurements probably represent fairly the thickness of the seam over the field lying between East Fork and Middle Fork. The seam appears to attenuate, however, both northward and eastward; at the Excello working it is only about 4 feet thick, and farther northward on the "grand divide" its thickness is probably still less. The area occupied by the Bevier coal is represented roughly and in part hypothetically upon the accompanying map, Fig. 1. West of East Fork this cartography is approximately correct; but east of that river its representation involves inferences as to altitudes, dip of strata, and the depth of the drift, which are liable to considerable error. Moreover, so rapidly does the seam attenuate northeastward that it is doubtful whether it will ever be found workable far east of the East Fork. It is questionable, too, whether it can be profitably worked much farther northward than Bevier. Over the entire Bevier-McGee College field the quality of the coal appears to be fully up to the standard already established for the well known Bevier coal of the markets; the height of the seam above the main drainage lines is such as to insure dry or easily drained workings; and its thickness appears to be maintained. On the whole, this may be regarded as one of the finest coal fields in the trans-Mississippi basin.

The 11-inch coal seam has been opened at different points along the East Fork and in the vicinity of Macon, but it is not now worked, and probably cannot be with profit under existing conditions.

So far as personally observed on East Fork, the Carbon coal is of quite uniform thickness, ranging from 17 to 18 inches;

but it is reported by citizens to thicken locally to 2, 3, 4½ and even 8 feet. Certainly it thickens materially eastward, as indicated by the Macon boring record of 21½ inches, and the observed thickness of 23 to 25 inches on Salt river—where, again, extravagant claims are made concerning its thickness and quality. It is a reasonable inference that the thickness continues to increase eastward until the bed is cut off by erosion probably near the county line, as the Bevier coal is cut off on the "grand divide"; and there is presumptively a corresponding attenuation westward. Its area is approximately represented in the accompanying map, Fig. 1. The Carbon coal was formerly worked largely at the now defunct town of Carbon and elsewhere; but since the great development of the Bevier mines took place its extraction has been confined to a few drifts and open workings operated in a small way to meet local demands. It is doubtful whether this field can be successfully brought into competition with the Bevier and other coal fields of Missouri, at least for the present, and for the portion lying westward of the "grand divide," but judicious prospecting and exploitation along and east of Salt river is advisable; and eventually the Carbon coal will form a resource of great value.

TRANSACTIONS.

The Pressure of the Wind on Roofs and Inclined Surfaces.

By J. H. Kinealy.

The formula generally used to calculate the normal pressure of the wind on a surface inclined at an angle to the direction of the wind is the one deduced by Unwin from experiments made by Hutton in 1786.

This formula is

$$N = P (\sin i)^{1.842 \cos i - 1},$$

where N is the normal pressure per square foot of surface; i, the angle of inclination with the direction of the wind; and P, the pressure per square foot of the same wind upon a surface perpendicular to its direction.

In making the series of experiments from which the above formula was deduced, a complete description of which is in Tract 36, 1788, titled "Resistance of the Air to Bodies in Motion," Hutton used an apparatus that consisted essentially of a small wooden lever fastened at one end to a cylinder that turned easily about a vertical axis. The cylinder was made to turn on the vertical axis by means of weights fastened to a cord wound about it. A small rectangular plane was fastened by one of its edges to the outer end of the lever. By noting the weights necessary to turn the cylinder, and making due allowances for friction, Hutton measured the resistance of the air to the plane when it was inclined at various angles to the horizon. It is evident from his description of the manner of making the experiment, that, although he does not mention the matter, Hutton, by the experiments, found not the *normal pressure* of the air on the plane, but the *horizontal component* of the normal pressure.

As a result of his experiments he gives the formula

$$R = P (\sin i)^{1.842 \cos i},$$

where P is the resistance when the plane is perpendicular to its direction of motion, and R the resistance when the plane is inclined at an angle i to the direction of motion.

If then $R = P\,(\sin i)^{1.842 \cos i}$ is the expression for the horizontal component for the pressure of the air on the plane, the normal pressure, N, on the plane is

$$N = \frac{R}{\sin i} = P\,(\sin i)^{1.842 \cos i - 1}.$$

This is the formula given by Unwin, and used by him to calculate the table of wind pressure on roofs published in his book on "Iron Bridges and Roofs."

This formula $N = P\,(\sin i)^{1.842 \cos i - 1}$ gives what seems to be some very peculiar results.

It is evident that N is equal to P when

$(\sin i)^{1.842 \cos i - 1}, = 1,$

and $(\sin i)^{1.842 \cos i - 1}, = 1$, when either

$\sin i = 1$, or when $1.842 \cos i - 1 = 0$,

$\sin i = 1$ when $i = 90°$; and $1.842 \cos i - 1 = 0$, when

$\cos i = \frac{1}{1.842}$ or $i = 57°\ 10'$.

In other words, the formula says, the normal pressure on a surface inclined at an angle of $57°\ 10'$ to the direction of the wind, is the same as it would be if the surface were perpendicular to the direction of the wind.

If the surface is inclined at any angle between $57°\ 10'$, and $90°$ N will be *greater* than P. Since for all such angles $1.842 \cos i - 1$ is less than zero, and $\sin i$, in the formula, has a negative exponent; and as $\sin i$ for any value of i less than $90°$ is less than unity, N becomes equal to P divided by a fraction.

From what has been said, it is evident that N has its maximum value for some value of i between $57°\ 10'$ and $90°$.

Differentiating the expression for N with respect to i, and putting the differential co-efficient equal to zero, we obtain the equation

$$-1.842\,(\sin i)^{1.842 \cos i} \log \sin i + (1.842 \cos i - 1) \cos i\,(\sin i)^{1.842 \cos i - 2} = 0,$$

whence $\log \sin i = \frac{1.842 \cos^2 i - \cos i}{1.842\,(1 - \cos^2 i)}$

Letting the right-hand member of the equation be represented by y, we have $\sin i = e^y$, where e is the base of the Naperian system of logarithms.

Expanding this expression, we have

$$\sin i = 1 + y + \frac{y^2}{2} + \frac{y^3}{6} + \&c.$$

Throwing away all of the terms but the first and second of the right-hand member and reducing, we have as an approximate result —

$$\sin i = \frac{1 - \dfrac{\cos i}{1.842}}{1 - \cos^2 i}.$$

Solving this equation by trial, we find that N will have its maximum value when i is about 68°.

These results given by the formula are incompatible with good theory, for the impulse of either a limited or an unlimited stream upon a plane inclined to its direction. The impulse of wind on a roof may be considered as that of an unlimited stream upon a plane surface of the same area and inclination as the roof.

According to Weisbach, if A is the area of a surface impinged upon by an unlimited current whose density is d and velocity v, the impulse on the surface when it is perpendicular to the direction of the current is

$$P = \frac{K\ v^2\ Ad,}{2g}$$

where K is a constant to be determined by experiment, and g is the acceleration due to the force of gravity.

According to Duchemin, when the surface is inclined at an acute angle i to the current, the impulse in the direction of the current is

$$\mathrm{R} = \frac{Kv^2 Ad \sin^2 i}{g\,(1 + \sin^2 i)} \qquad \text{(See Weisbach's Mech.)}$$

Dividing this expression by the former, we obtain

$$R = \frac{2\ P \sin^2 i}{1 + \sin^2 i} = \frac{P}{1 + \dfrac{\cot^2 i}{2}}$$

R in this formnla represents the ***horizontal component*** of the normal pressure, and *not* the normal pressure, as was stated in the Annals of Math., vol. 1, No. 2, p. 44.

Duchemin applied this formula to the results of experiments made by Vince, by Hutton, and by Thibault, and found it to agree with the results of all better than did the formula, given on page 337 that was deduced by Hutton from his experiments alone. (See Annals of Math., vol. 1, No. 2.)

The normal pressure is $N = \frac{R}{\sin i}$, and the vertical component of the normal pressure is $V = R \cot i$.

From the formula $N = \frac{R}{\sin i} = \frac{2\, P \sin i}{1 + \sin^2 i}$

it is evident that $N = P$ when $2 \sin i = 1 + \sin^2 i$, whence $\sin i = 1$, or $i = 90°$. For *all* values of i less than 90° N is less than P, as it would seem should be the case.

From $V = R \cot i = \frac{P \cot i}{\frac{1 + \cot^2 i}{2}}$ it is seen that V is equal to P when $\cot^2 i - 2 \cot i = -2$. Whence $\cot i = 1 \pm \sqrt{-1}$. A result that indicates that V is never equal to P. V is equal to zero when $\frac{\cot i}{\frac{1 + \cot^2 i}{2}} = 0$, which is true when $\cot i = 0$, or $i = 90°$, and also when $\cot i = \infty$, or $i = 0°$.

Differentiating the expression $V = \frac{P \cot i}{\frac{1 + \cot^2 i}{2}}$, and putting the differential co-efficient equal to zero and reducing, we have

$$\frac{\cot^2 i - 2}{(2 + \cot^2 i)^2} = 0.$$

Whence we see that V is a maximum when $\cot i = \sqrt{2}$, or i is about 35° 15′.

The results obtained by using the formula $N = \frac{2\, P \sin i}{1 + \sin^2 i}$ agree not only with good theory, but also with the results of experiments, and, therefore, it is the formula that should be used in calculating the wind pressure on roofs and bridges.

TABLES.

TABLE 1 gives the values of the horizontal component of the pressures per square foot of inclined surface, as deduced for various angles by Hutton's formula and also by Duchemin's, when P is equal to 40 pounds per square foot.

TABLE 2 gives the normal pressures per square foot of inclined surface, as deduced by Unwin's formula and also by Duchemin's, when P is equal to 40 pounds per square foot.

TABLE 3 is designed for the use of engineers and architects, and gives the normal pressure with its horizontal and vertical components upon each square foot of inclined surface when P is assumed as 40 pounds per square foot.

The Plate shows the two curves represented by the polar equations used to calculate Table 2, drawn to a scale of 16 pounds to the inch.

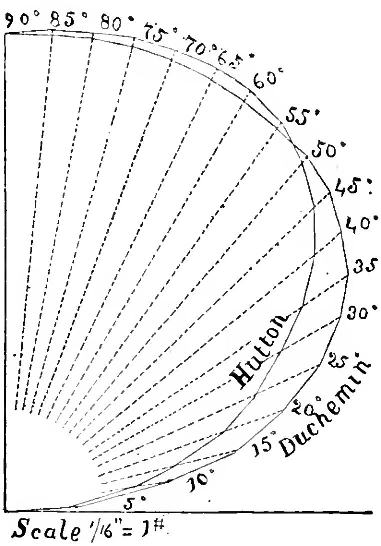

TABLE 1.

Angle of Inclination.	HUTTON. $R=P(\sin i)^{1.842\cos i}$	DUCHEMIN. $R=\frac{P}{\frac{1+\cot^2 i}{2}}$	Angle of Inclination.	HUTTON. $R=P(\sin i)^{1.842\cos i}$	DUCHEMIN. $R=\frac{P}{\frac{1+\cot^2 i}{2}}$
5°	0.454	0.600	50°	29.175	29.584
10°	1.670	2.344	55°	32.383	32.120
15°	4.515	4.984	60°	35.037	34.280
20°	6.245	8.376	65°	37.051	36.080
25°	9.552	12.123	70°	38.417	37.512
30°	13.240	16.003	75°	39.344	38.616
35°	17.290	19.804	80°	39.805	39.384
40°	21.440	23.390	85°	39.975	39.848
45°	25.469	26.666	90°	40.000	40.000

TABLE 2.

Angle of Inclination.	UNWIN. $N=P(\sin i)^{1.842\cos i-1}$	DUCHEMIN. $N=\frac{2P\sin i}{1+\sin^2 i}$	Angle of Inclination.	UNWIN. $N=P(\sin i)^{1.842\cos i-1}$	DUCHEMIN. $N=\frac{2P\sin i}{1+\sin^2 i}$
5°	5.214	6.919	50°	38.086	38.620
10°	9.620	13.485	55°	39.532	39.217
15°	13.956	19.450	60°	40.457	39.590
20°	18.260	24.496	65°	40.881	39.808
25°	22.601	28.686	70°	40.882	39.922
30°	26.480	32.000	75°	40.732	39.976
35°	30.144	34.527	80°	40.420	39.995
40°	33.355	36.388	85°	40.128	39.999
45°	36.019	37.713	90°	40.000	40.000

TABLE 3.

Angle of Inclination i.	NORMAL PRESSURE. $N=\frac{2P\sin i}{1+\sin^2 i}$	HOR. COMPONENT. $R=\frac{2P\sin^2 i}{1+\sin^2 i}$	VERTICAL COMPONENT $V=\frac{P\cot i}{\frac{1+\cot^2 i}{2}}$
0°	0.000	0.000	0.000
5°	6.919	0.600	6.894
10°	13.485	2.344	13.280
15°	19.450	4.984	28.788
20°	24.496	8.376	23.019
25°	28.686	12.123	25.998
30°	32.000	16.003	27.718
35°	34.527	19.804	28.283
40°	36.388	23.390	27.875
45°	37.713	26.666	26.666
50°	38.620	29.584	24.826
55°	39.217	32.120	22.494
60°	39.590	34.280	19.795
65°	39.808	36.080	16.823
70°	39.922	37.512	13.654
75°	39.976	38.616	10.346
80°	39.995	39.384	6.945
85°	39.999	39.848	3.499
90°	40.000	40.000	0.000

CONTRIBUTIONS FROM THE SHAW SCHOOL OF BOTANY.

No. 5.

Revision of North American Ilicineæ and Celastraceæ.

By William Trelease.

(Presented Feb. 4, 1889.)

Pending the desired continuation of Dr. Gray's Synoptical Flora, I have thought best to place the following synopsis of these small Orders in the hands of botanists, in the hope of securing information and material needed for some species. The manuscript, based on a study in 1887 of the material in the Gray-Torrey and Engelmann herbaria, has been used in an examination of the specimens contained in the herbarium of the Department of Agriculture, in that of Mr. I. C. Martindale, and, more recently, of the herbaria at Kew and Berlin. For the privilege of using the large collections named, and for other material kindly placed in my hands by correspondents, I am very grateful.

Both Orders are taken in the sense of Bentham and Hooker, Gen. i. The first includes, besides our two genera, only the small Pacific genera *Byronia*, Endl., and *Sphenostemon*, Baill. The second comprises some 400 species belonging to 39 genera,—largely tropical.

ILICINEÆ.

So far as our flora is concerned, *Ilex* is represented by endemic species limited to the eastern half of the continent; but some of them are represented by closely related eastern Asiatic species. Bentham and Hooker recognize about 145 species, all told. The only recent comprehensive study of the genus is by Maximowicz, in Mém. Acad. Imp. St. Pétersb. 1881, ser. 7, xxix. No. 3, where about 170 species are admitted, of which 120 have been studied by the author. The greater number belong to tropical regions, especially of this continent. *Nemopanthes* includes only the one species of our flora.

Biologically, there is little of interest in the species of either genus. The leaves of *Ilex aquifolium*, the European holly, and of its American representative, *I. opaca*, are known to be variable as regards the pungent toothing of their margins, and it has been observed that the upper branches are apt to bear more entire leaves than the lower, as though in correlation with their smaller need of protection, removed, as they are, from the reach of herbivorous animals, or protected from them by the lower part of the plant. As a parallel case, it may be observed that the upper branches of the Osage orange (*Maclura aurantiaca*) are commonly spineless, while the lower bear spines; but this, of course, adduces no real proof as to the cause of the observed variability.

The flowers of both genera are small and not conspicuous, though the petals may be more or less white. All our species appear to be polygamo-diœcious, from the abortion of stamens or pistils.* The cross-fertilization which this separation of the sexes necessitates, is effected by small insects, chiefly Diptera — though Hymenoptera and even Lepidoptera visit them to a certain extent†—attracted by pollen or the very accessible nectar at the base of the flowers.‡

Dissemination is brought about by birds which feed upon the pulpy fruit, the seeds being enclosed within stony, indigestible nutlets.§ The red-fruited species often show yellow-fruited races, but these are scarcely more worthy of varietal name than floral albinos of other groups. Parenthetically, it may be said that this remark applies equally to the white-fruited races of *Gaylussacia*, *Fragaria*, &c.

The Hollies, like many other woody plants now abundant in our flora, appear to have become well established in the Tertiary age. *Nemopanthes* is said by Schimper to have had one representative at that time,‖ and *Ilex* occurred in numerous species which, as a result of the mild climate of high latitudes, reached into the far north of what are now the two great continents,

* *Cf.* Darwin: Different Forms of Flowers, 297-8.

† See Delpino: Ult. Osservazione, ii. (2), 300, and Just's Jahresbericht, 1875, 895. It is doubtful if they are at all anemophilous, as suggested by Meehan in Proc. Philad. Acad. 1877, 128.

‡ Bonnier states that the entire abortive ovary in male flowers of *I. aquifolium* serves as a nectary.—Ann. Sc. nat. 1879, viii. 140.

§ See Huth: Kosmos, ix. 282, and Verbreitung der Pflanzen durch die Excremente der Thiere, 1889, 11. Many scattered observations on this subject occur in journals such as Nature and Hardwick's Science Gossip.

‖ Traité de Paléontol. Vég.—Just. 1874, 680.

whence they were driven by the subsequent cold of the Glacial period, which ushered in the Quatenary. It is interesting to observe the distribution of this genus over our western country, Europe, &c., in Tertiary times, in contrast with its present limitation.

SYNOPSIS.

ILEX, L.—Shrubs or small trees with short-petioled leaves and minute pointed stipules: flowers 4- to 9-merous: calyx present and persistent in both fertile and sterile flowers; corolla somewhat gamopetalous at base, its lobes oblong and very obtuse; stamens adnate to the base of the short tube.—Gen. No. 172: Benth. & Hook, *l. c.* 356; Maximowicz, *l. c.*—Including *Prinos*, L. and *Aquifolium*, Tourn., as well as several genera of Rafinesque. The reader should consult Watson's Bibliographical Index for synonymy.

* Flowers 4-merous; drupe red or occasionally yellow; nutlets prominently few-ribbed on the sides and back: leaves coriaceous, evergreen.—§ *Aquifolium*, Gray, Manual, 1 ed. 276.—*Aquifolium*, Tourn.

I. OPACA, AIT.—Tall shrub, or in the south a tree as much as 45 ft. high; young twigs sparingly velvety-pubescent: leaves broad, 2 to 4 in. long, elliptical to obovate-oblong, pungently acuminate, mostly spinosely dentate, at least above: petiole and upper surface of midrib somewhat puberulent: sterile cymes 3- to 9-flowered, mostly 12 to 24 mm. long; fertile, 1- (rarely 3-) flowered, 6 to 12 mm. long, the puberulent peduncle bibracteate at or below the middle; calyx segments acute, ciliate, especially in the fertile flowers; stigma very broad, sessile; drupe spheroidal or ovoid, 8 to 10 mm. long.—Hort. Kew (1789) i. 169; Watson, Index, 160; Maximowicz, *l. c.* 29; Sargent, Forest Trees of N. A. 34: Mellichamp, Bull. Torrey Bot. Club, viii. 112.—Massachusetts to Florida, west to s.e. Missouri and Texas. I have seen no specimens collected north or east of New York.

2. I. DAHOON, WALT.—Shrub or small tree not over 25 ft. high; young growth and lower surface of leaves, at least the midrib, usually pubescent; leaves rather narrow as contrasted with the last, 2 or 3 in. long, elliptical or mostly oblanceolate to obovate-oblong, usually cuneate, obtuse, acute, or somewhat mucronate but not pungent, entire or with a few remote firm serratures above: inflorescence nearly as in the last, but the fertile cymes commonly 3-flowered: calyx segments acute, more or less ciliate; drupes subglobose, 4 to 6 mm. in diameter, on pedicels of equal length, mostly 3 from a common peduncle of the same length.—Fl. Carol. (1788), 241; Watson, Index, 158; Maximowicz, *l. c.* 26; Sargent, *l. c.* 35.—Virginia to Florida. Passes through a form with elongated narrow leaves (*I. angustifolia*, Willd. Enum. 172) into the variety.

VAR. MYRTIFOLIA, CHAPM. With crowded mostly entire mucronate glabrate leaves, frequently only 8 to 10 mm. long, and shorter-stalked drupes.—Chapm. Fl. So. States (1860), 269; Watson, *l. c.* 158. *I. myrtifolia*, Walter, *l. c.* 241; Maximowicz, 26. 31; T. F. Wood, Bull. Torrey Bot. Club, xi. 136.—North Carolina to Florida, west to Louisiana.

3. I. CASSINE, WALT.—Shrub or occasionally arborescent; twigs and petioles puberulent; leaves half inch to inch and a half long, elliptical or elliptical-oblong, very obtuse, coarsely crenate-serrate, with a deciduous gland or denticle at each sinus; sterile cymes about 8 mm. long, short-peduncled; fertile, sessile, 1- to 3-flowered; calyx segments rounded, scarcely ciliate; ovary contracted below the stigma; drupes round, 4 to 6 mm. in diameter, on pedicels of equal length.—*l. c.* (1788), 241; Watson, 158; Maximowicz, 22; Sargent, 36.—Virginia to Florida and Bermuda, west to Arkansas and Texas.

An effort to improve on the nomenclature of this species, unless it is called *I. Cassine*, β. L. Sp. (1753), 125, would probably cause it to stand as *I. Peragua* (L.) = *Cassine Peragua*, L. Mantiss. (1771), ii. 220.

* * Flowers 4- to 6- merous; drupe red or purple; nutlets as in the last; leaves deciduous. —§ *Prinoides*, Gray, *l. c.* 276.

+ Cymes 1-flowered, bractless.

++ Leaves typically spatulate to obovate, at length firm but not thick, crenate-serrulate.

4. I. DECIDUA, WALT.—Shrub or small tree with glabrous gray twigs: leaves 2 or 3 in. long, glossy above and narrowly grooved along the midrib, pubescent below, at least on the midrib; cuneate-obovate or mostly spatulate-oblanceolate, blunt-acuminate to obtuse or emarginate, the low teeth tipped with minute glands; petiole mostly pubescent; flowers appearing with the leaves; sterile pedicels 6 to 12 mm. long; calyx segments broadly triangular, mostly dark-pointed and scarcely ciliate; drupes depressed globose, about 6 mm. in diameter, usually with short styles.—*l. c.* (1788), 241; Watson, 158; Maximowicz, 30; Sargent, 37.—Virginia to Florida, west to Missouri and Texas.

++ ++ Leaves ovate to lanceolate, rather thinner except in one variety, sharply serrate.

5. I. LONGIPES, CHAPMAN, ined.—Related to the last; leaves a couple of inches long, elliptical to very broadly lanceolate, sparingly ciliate with short broad hairs, otherwise glabrous; drupes about 8 mm. in diameter, globose, solitary on pedicels about an inch long.—North Carolina (*Buckley*) to Tennessee (*Gattinger*), Alabama (*Buckley*, *Beaumont*), and Louisiana (*Drummond*).—*Nemopanthes Canadensis*, Gattinger, Tennessee Flora, 31.

6. I. AMBIGUA, CHAPM.—Shrub or small tree with mostly glabrous twigs; leaves an inch or two long, slightly glossy, glabrous or with scattered hairs on the petiole and upper side, especially along the midrib, ovate or lanceolate, mostly acute or acuminate, the base acute, sparingly

serrate with low sharp teeth, or biserrate; calyx segments rounded, usually strongly ciliate; drupes subglobose, about 6 mm. in diameter, their pedicels one-half shorter.—Fl. So. States (1860), 269; Watson, 157; Maximowicz, 30.—North Carolina to Florida, west to Arkansas and Texas.

The earliest name appears to be *Cassine Caroliniana*, Walter, *l. c.* (1788), 242. If this specific name is to be accepted, the plant becomes *I. Caroliniana* (Walt.) The *Cassine Caroliniana* of Lam. Dict. i. 652 (1783), is *I. Cassine*.

VAR.(?) CORIACEA. Leaves glabrous, firm and apparently evergreen.—Tampa. Florida (*Garber*, 1877).

7. I. MONTICOLA, GRAY.—Leaves large, 2 to 5 in. long, frequently rounded at base, with more conspicuous serrations, and usually sparingly hairy along the veins on both sides; calyx segments rather acute and less ciliate; drupes spheroidal, with an evident style.—Manual (1867), 306; Watson, 159; Maximowicz, 30; Chapman, Supplement, 633.—Mountains, New York to Alabama.

8. I. MOLLIS, GRAY.—At first closely soft-pubescent, the twigs and upper surface of the leaves at length glabrate; leaves more broadly ovate: otherwise resembling the last, of which it is, perhaps, only a well-marked variety.—*l. c.* (1867), 306; Watson, 159; Maximowicz, 30; Chapman, Suppl. 633.—Mountains, Pennsylvania to Georgia.

As the *Prinos dubius* of Don, Mill. Dict. (1832), this becomes *I. dubia* (Don.) of the Torrey Club Catalogue.

+ + Sterile cymes several-flowered from a common peduncle.

9. I. AMELANCHIER, M. A. CURTIS.—Low shrub, somewhat pubescent; leaves an inch and a half to 3 in. long, elliptical to lance-oblong, inconspicuously or low serrulate, downy or finally glabrate above, the lower surface rugose-reticulate; stipules apparently rudimentary; calyx segments acute, scarcely ciliate; drupes globose, about 10 mm. in diameter, solitary on bractless pedicels as much as 18 mm. long.—Chapman, Fl. So. States (1860), 270; Watson, 157; Sargent, Garden & Forest, ii. 40, with illustration.—Borders of swamps, Society Hill, South Carolina (*Curtis*), Covington, La. (*Drummond*, 1832, in hb. Kew and Brit. Mus.), "Alabama" (*Drummond*) in hb. Kew.

* * * Flowers 6- to 9-merous; drupe red or black; nutlets not ribbed.—§ *Prinos*, Gray, Manual, 5 ed. 307. *Prinos*, L.

+ Leaves coriaceous and evergreen, dotted below; fruit black.

10. I. GLABRA, GRAY.—Low shrub; young twigs finely puberulent: leaves an inch or two long, cuneate-elliptical to oblanceolate, crenately 2- to 6-toothed near the mostly obtuse apex, the teeth ending in minute appressed serratures; staminate and sometimes fertile peduncles several-flowered, bibracteate; calyx segments variable in form and ciliation; drupes subglobose, 4 to 6 mm. in diameter, their pedicels of equal length; style scarcely evident.—Man. (1867), 307; Watson, 159; Maximowicz, 26. *Prinos glaber*, L. Sp. (1753), 330.—Near the coast, Nova Scotia(!),

Massachusetts to Florida and Louisiana; chiefly southern. A specimen of this species (!) in hb. Kew is labeled "Saskatchewan, Drummond."

11. I. LUCIDA, TORR. & GR. — Taller shrub; leaves 2 or 3 in. long, the larger oblanceolate, not at all crenulate, mostly acuminate, with a few appressed slender serratures above; peduncles 1-flowered, bractless; style often prominent; otherwise much like the last. — Watson, Index (1878), 159: Maximowicz, 26. *Prinos lucidus*, Ait. l. *c.* (1789), i. 478. — Georgia, Florida, Alabama, and Louisiana.

+ + Leaves thinner, deciduous, not punctate; fruit red or occasionally yellow.

12. I. VERTICILLATA, GRAY.—Shrub, usually tall; young growth mostly soon glabrate; leaves 2 or 3 in. long, lanceolate or oblanceolate to cuneate-obovate, obtuse to acuminate, serrate or biserrate, veiny, the lower surface commonly with persistent pubescence, blackening before they fall in autumn; sterile cymes fascicled, motly short and 3-flowered, but occasionally ample and forked; the fertile, 1- or occasionally 3-flowered from an often rudimentary bibracteate peduncle; calyx segments usually obtuse, loosely hairy and ciliate; drupes subglobose, styleless, 6 mm. in diameter, on pedicels of scarcely equal length.—*l. c.* (1867), 307; Watson, 160; Maximowicz, 30; W. W. Bailey, Bull. Torrey Club, ix. 152. *Prinos verticillatus*, L. Sp. (1753), 330. — Canada to Florida, west to Wisconsin and Missouri.

Two forms have received varietal names — var. *tenuifolia*, Torr. Fl. U. S. (1824), 338, and var. *padifolia*, T. & Gr. in Watson, *l.c.* (1878), 160,— but the species is so variable that it has scarcely seemed to me desirable to keep them up.

13. I. LÆVIGATA, GRAY. — Low shrub; twigs glabrous; leaves about as large as in the last, lanceolate, mostly acute, crenate-toothed or low serrulate, veiny, somewhat villous on the midrib and principal veins below, turning yellow in autumn; sterile flowers solitary on bractless pedicels a half inch long, the fertile shorter-stalked; calyx segments mostly acute, glabrous, not ciliate; drupes ripening somewhat earlier than in the last, usually short-styled, subglobose, 6 to 8 mm. in diameter, on pedicels of equal length. — *l. c.* (1867), 307; Watson, 159; Maximowicz. 30. *Prinos lævigatus*, Pursh, Fl. i. (1814), 220. — New England to Virginia, west to Pennsylvania. I have seen no specimens collected north of Massachusetts nor south of New Jersey.

14. I. LANCEOLATA, CHAPM.—Twigs glabrous; leaves 2 or 3 in. long, thin, lanceolate or ovate-lanceolate, tapering to both ends, serrulate or biserrulate, not very veiny, glabrous or with a few fine hairs above, especially on the petiole and midrib; sterile flowers umbellately clustered on pedicels about 3 lines long, the fertile 1 to 3, from a rudimentary peduncle; calyx segments rounded, ciliate; drupes subglobose, about 6 mm. in diameter, on shorter pedicels, red(?) or in the herbarium black. — *l. c.* (1860), 270; Watson, 159; Sargent, Gard. & Forest, ii. 40. *Prinos lan-*

ceolatus of Pursh, *l. c.* 220, and, presumably, Hill, Veg. Syst. (1770), xvi. pl. 61.—Georgia and Louisiana.

Regarded by Watson and Sargent as a very doubtful species. My description is based upon rather unsatisfactory specimens from Dr. Chapman, in the herbarium of Columbia College. If this stands, the *Ilex lanceolata* of Grisebach, Cat. Pl. Cub. Wright. (1866), 56, may bear the name *I. Wrightii*.

NEMOPANTHES, RAF.—Shrub with slender-petioled nearly estipulate leaves; flowers 4- to 5-merous; calyx obsolete in the fertile flowers; petals distinct, linear, acute; stamens free.—Journ. Phys. (1819), 96; Benth. & Hook. *l. c.* 357.

1. N. CANADENSIS, DC.—Glabrate; leaves half inch to 2 in. long, elliptical, often somewhat acute at both ends, mostly mucronate, entire or sparingly low-serrate, finely reticulate-veined; flowers solitary on slender bractless pedicels half inch to 1 in. long; drupe red, ovoid, styleless, about 6 mm. in diameter; nutlets faintly ribbed on the back.—Mém. Soc. Gen. (1821), i. 450; Watson, Index, 160.—Canada to the mountains of Virginia, west to Minnesota and Indiana.

As *Vaccinium mucronatum*, L. Sp. (1753), 350, was founded on a fruiting specimen of this according to Dr. Gray (Syn. Fl. ii. 20), the attempted change in principles of nomenclature would cause it to bear the name *N. mucronata* (L.)

CELASTRACEÆ.

This group is somewhat heterogeneous in the sense in which Bentham and Hooker accept it, and especially as it is limited by Baillon (Hist. Nat. des Pl. vi.), but there appears to be no very good reason for recognizing the component Tribes as of ordinal rank.

Euonymus, which comprises about 40 species, centering about Southern Asia, is represented with us by 4 endemic species rather closely related to those of Europe and Eastern Asia. Like *Ilex*, it was established, especially in the old world, in the Tertiary age, although it may have originated earlier.* Two common European species, *E. Europæus* and *E. latifolius*, are said by Saporta† to have existed in Europe during the Quaternary period. Pollination is effected mainly through the agency of flies and small bees, chiefly the former, which feed upon the readily accessible nectar, crossing being favored by protandry in the Euro-

* For a Post-Cretaceous species see Ward; Bull. U. S. Geol. Surv. 1887, No. 37, p. 82.

† Bull. Soc. Géol. de France, 1874; Just's Jahresbericht, 1874, 644.

pean species which have been studied,* or by the abortion of one of the sexes. Dissemination of the ripened seeds is effected by birds which eat them for the sake of the fleshy colored aril, ultimately disgorging the uninjured seeds, according to Huth.† The mechanism by which weakly twigs are cast off (as in poplars, elms, willows, and many other woody plants), is described by von Höhnel in a comprehensive study of the subject.‡

Pachystima is represented only by our two species, one of very narrow geographical distribution; the other showing more clearly the arctic-alpine character of the genus. No biological observations on either species have come to my notice.

Celastrus, represented in our flora by the single common form, comprises some 18 or 20 species, largely of India and eastern Asia. Like *Euonymus*, this genus was represented in Tertiary times by many more species than at present. Lesquereux describes three North American species from the Green River Tertiary; and Ward§ refers here 7 new species of the Post-Cretaceous Laramie formations. The pollination of the flowers of *C. scandens* is briefly discussed by Sprengel.‖ Dissemination is effected by birds attracted by the aril, as in *Euonymus;* and, as in that genus, the contents of the seed are protected chiefly by a single layer of sclerotic cells.

Maytenus, a genus peculiar to the American continent, includes about 50 species, with a maximum development in the tropics, from which a number of species reach into temperate South America, while only one comes into the flora of our warmer region. Several Tertiary species referred to this genus occurred in more northern parts of the old world. Nothing is known to me of the biology of our existing representative of the genus.

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* *Cf.* Darwin: Different Forms of Flowers, 287 (sexual relations of *E. Europæus*). Delpino: Ult. Oss. ii. (2), 300, 302, Just, 1875, 883, 895 (fetid odor of *E. verrucosus*, agency of Diptera, &c.) Fournier: De la Fécondation dans les Phanérogames—Thesis, Paris, 1863,—118 (protandry). Mueller: Befruchtung der Blumen (1873), 153; and English translation (*E. Europæus*).

† Kosmos, x. 279, 287; Verbreitung der Pflanzen durch die Excremente der Thiere, 11. On the structure of the protective seed-coats, see Weiss: Allgemeine Botanik, i. *fide* Just, 1878 (1), 31.

‡ Mittheil. forstl. Versuchswesens für Oesterreich, Heft 3; Just, 1878 (1), 94.

§ Bull. U. S. Geol. Survey, No. 37, 1887, 77.

‖ Entdeckt. Gerheimniss der Natur, 131.

Myginda is a genus barely separable from the last except in the dehiscence of its fruit. Its few species are peculiar to tropical America. So far as our flora is concerned, it is represented by some of the more characteristic species of the West Indies and adjacent Central America, which have become settled in the sub-tropical Florida region. I have no references concerning their biology.

Schæfferia includes only our species, one of which belongs to the Texano-Mexican region, and the other to the West Indian region. The small disk and large divided stigma of this genus are quite aberrant in the Order. Nothing appears to have been published on its biology.

If, as I believe, *Mortonia Palmeri*, Hemsley, of Mexico, is only a form or variety of *M. Greggii*, this genus likewise includes only our species, which belong to the Texano-Mexican region. Nothing has been written on their biology.

Hippocratea is a tropical genus of wide distribution, including about 60 species, chiefly centering about Brazil. Our single representative belongs to the West Indies and Central America, and has established itself barely within our limits, like the species of *Myginda*. Several Tertiary species are described from more northern latitudes. The prehensile twigs of a species of this genus are described by Fritz Müller.* The winged seeds are adapted to dissemination by the wind. Nothing appears to have been written about the pollination of species of the genus.

SYNOPSIS.

TRIBE I. CELASTREÆ.—Stamens 4 or 5, inserted on or below the margin of the disk; seed albuminous except in some species of *Maytenus*.

* Leaves opposite; fruit dehiscent. — § *Euonymeæ*.

1. EUONYMUS —Flowers seemingly hermaphrodite but really polygamo-triœcious, 4- or 5-merous; calyx shallow; filaments very short; anthers didymous, the subglobose cells dehiscing across the top; style short, terminal; ovary immersed in the disk, 3- to 5-celled, with mostly a pair of ascending or pendent ovules in each cell; capsule more or less lobed, coriaceous, colored, with usually a single seed in each cell; seeds enclosed in a scarlet or orange aril.

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* Kosmos, 1882, xii. 323; Jour. Linn. Soc. Bot. 1865, ix. 345.

2. Pachystima. — Flowers hermaphrodite, 4-merous; calyx shallow; filaments longer than the round anthers; style short, at length commonly unilateral; stigma capitate; ovary nearly immersed in the disk, 2-celled, with a pair of erect ovules in each cell; capsule oblong, 2-edged, usually 1-seeded and inequilateral by abortion, tardily loculicidal; seed with a pale lacerate aril at base.

* * Leaves alternate; fruit dehiscent. — § *Celastreæ.*

3. Celastrus. — Flowers subdiœcious, 5-merous; calyx cup-shaped: filaments longer than the oval mucronate anthers: style short. terminal. slightly 3-lobed; ovary free. usually 3-celled, with a pair of erect ovules in each cell; capsule orange, more or less completely 3- to 4-celled, with usually a single seed in each cell; seed enclosed in a red aril.

4. Maytenus.—Flowers polygamo-diœcious; calyx shallow; filaments longer than the round-cordate anthers; ovary confluent with the disk below, narrowed to the slightly lobed stigma, usually 3- or 4-celled, with an erect ovule in each cell; capsule obovoid, triquetrous, imperfectly 3- to 4-celled and as many seeded; seeds with a red aril open above.

* * * Leaves alternate or opposite; fruit indehiscent. — § *Elæodendreæ.*

5. Myginda.—Flowers hermaphrodite, 4- or 5- merous; calyx shallow cup-shaped; filaments thrice as long as the round anthers; style short and terminal, or elongated and then commonly unilateral; ovary partly immersed in the disk, 1- to 4-celled.

6. Schæfferia. — Flowers diœcious, 4-merous; calyx shallow; disk small: filaments thrice as long as the round-oval anthers; style terminal: stigma 2-cleft, with large incised or fimbriate divisions; ovary free, 2-celled, with an erect ovule in each cell; drupe spheroidal, compressed or grooved when immature, 2-celled; seeds not arillate.

7. Mortonia. — Flowers hermaphrodite, 5-merous and symmetrical: calyx obconic; filaments thrice as long as the subglobose mucronulate anthers; style terminal, 5-lobed; ovary free from the crenulate disk, 5-celled. with a pair of erect ovules in each cell: fruit oblong, fluted, dry, 1-celled by abortion; seed solitary, filling the ovary, not arillate.

Tribe II. Hippocrateæ. — Stamens 3, mostly adnate to the ovary below; seed exalbuminous.

8. Hippocratea.— Flowers hermaphrodite, 5-merous; calyx shallow; filaments about as long as the didymous anthers; style short, terminal, somewhat 3-lobed; ovary 3-celled, with several axile ovules in each cell; fruit capsular, the carpels compressed and wing-like above, united only at base, the outer half of each falling away; seeds several in each cell, flat, winged at one end.

EUONYMUS, Tourn. — Shrubs or small trees with incurved-serrate ample leaves, and rather few-flowered dichotomous axillary cymes on elongated peduncles; flowers large for the Order, white or greenish to brown-purple. — Inst. 617; L. Gen. 271; Gray, Gen. ii. 187; Benth. & Hook. Gen. i. 360.

* Corolla greenish; fruit rough with crowded acute warts.

1. E. Americanus, L. — Low shrub; leaves inch and a half to 3 in. long, ovate or ovate-lanceolate, acute or rounded at base, acuminate, crenate-serrate, with a minute mostly incurved denticle at apex of each tooth, glabrous except for occasional short pubescence toward the base of the principal veins; petiole 2 mm. long, mostly pubescent when young; peduncles not over 1 in. long, 1- to 3-flowered; flowers 6 to 12 mm. in expanse; sepals round, entire; petals orbicular-rhomboid, abruptly short-clawed, with undulate frequently erose margins; fruit not deeply lobed. — Sp. (1753), 197; Watson, Index, 161. — Moist woods, New York to Florida, west to Arkansas and Texas. — I have seen no specimens collected north of New Jersey.

Var. angustifolius, Wood.—Leaves linear-lanceolate, somewhat falcate. — Bot. & Fl. (1870), 76; Watson, 162. *E. angustifolius*, Pursh, Fl. i. (1814), 168.— Georgia (fide *Pursh*), Florida (*Gray*).

Var. sarmentosus, Nutt. — Trailing and rooting, otherwise like the type. — Gen. i. (1818), 154; Watson, 162. — Southern range of the type.

Var. obovatus, Torr. & Gr.—With decumbent, often rooting branches; leaves obovate or elliptical-obovate, rather obtuse; flowers small (6 mm.), with approximated petals and mostly erose sepals.— Gray, Gen. ii. (1849), 188; Watson, 162; J., Garden and Forest, i. 212. *E. obovatus*, Nutt. Gen. i. (1818), 155. — Canada (*Macoun*) to Pennsylvania (fide *Nuttall*) and Kentucky (*Short*). Blooming earlier than its congeners.

* * Corolla brown-purple with pale margin (white in the second); fruit not tuberculate.

+ Atlantic species with 4-merous flowers and small winter buds (2 to 4 mm. long).

2. atropurpureus, Jacq.— Shrub or small tree; twigs at length with crowded lenticels; leaves inch and a half to 4 in. long, elliptical or ovate, conspicuously acuminate, irregularly serrulate or biserrulate, mostly puberulent on the lower surface; petioles 6 to 18 mm. long; peduncles slender, 1 to 2 in. long, the twice or thrice dichotomous cymes usually 7- or 15-flowered, with prominent bract-scars; flowers about 12 mm. in expanse; sepals rounded or somewhat acute, mostly entire; petals obovate, undulate and usually erose; fruit deeply lobed. — Hort. Vindob. ii. (1772), pl. 120; Watson, 162; Sargent, Forest Trees, 38 —Woods, Canada to Florida, west to Montana and Indian Territory. Flowering later than related species.

E. Europæus, L. — Related to the last, but the cymes mostly 3- to 7-flowered, and the 4 or 5 petals greenish-white or yellowish. — Sp. (1753) 197; Torrey Club Cat. Anthoph. & Pteridoph. 11. *E. vulgaris*, Scop. Fl.

Carniol. (1760); Nyman, Consp. Fl. Europ. 144. — Often cultivated, like the last, and persistent in old gardens about New York city (*Britton*), but scarcely naturalized.

+ + Species of the Pacific coast, with 5-merous flowers and larger oblong winter buds.

3. E. OCCIDENTALIS, NUTT.—Tall shrub; buds 4 to 6 mm. long; leaves ovate to lanceolate, acute or acuminate, the lowest rounded or subcordate, the others acute at base, irregularly serrulate or biserrulate, glabrous; petioles 4 to 8 mm. long; peduncles mostly elongated, 1- to 3-flowered; flowers 10 to 12 mm. in expanse; sepals obtuse, glandular-ciliate; petals round-obovate, undulate and somewhat cucullate, mottled; fruit not deeply lobed. — Torrey in Pac. R.R. Rep. iv. (1856), 74; Watson, 162. — Oregon and California.

4. E. PARISHII, N. SP. — Weak shrub 8 to 10 ft. high; ends of twigs flattened; buds 6 to 10 mm. long; leaves glabrous, elliptical-ovate, finely crenate-serrulate, obtuse or blunt-pointed, abruply contracted and cuneate at base; peduncles 2 in. long, 3- to 7-flowered; flowers about 6 mm. in expanse; otherwise similar to the last.— San Jacinto Mountains, California (*S. B. & W. F. Parish*, No. 957).

PACHYSTIMA, RAF. — Low shrubs with corky-areolate branches, nearly sessile coriaceous small leaves low-serrate toward the apex, and very small brownish flowers solitary or in short-stalked axillary cymes.— Am. Monthly Mag. 1818, fide Benth. & Hook. Gen. i. 361.

1. P. CANBYI, GRAY. — Span or two high, with rooting branches; leaves very obtuse, oblong or the lowest rarely obovate; peduncles 1- to 3-flowered, bibracteate, the elongated slender pedicels again bibracteate toward the base; fruit elongated ovoid, 4×8 mm. — Proc. Amer. Acad. viii. (1873), 623; Watson, 163; Meehan, Native Fl. & Ferns, i. 173, pl. 44; Chapman, Suppl. 613. — Rocky places in the mountains of southern West Virginia (*Gray*) and western Virginia (*Canby, Shriver, Redfield*).

2. P. MYRSINITES, RAF.—A foot or two high, erect or spreading; leaves elliptical to round-oval or occasionally oblanceolate-oblong; peduncles very short, mostly 3-flowered, the short pedicels scarcely exceeding them, bibracteate at or about the middle; fruit as in the last. — *l. c.;* Watson, 163, 460; Coulter, Rocky Mt. Bot. 46. *Ilex(?) myrsinites*, Pursh, Fl. i. (1814), 119.—Mountains, British America to California, extending along the Rocky Mountains into Mexico.

CELASTRUS, L.—Twining shrub with terete branches, ample serrate petioled leaves, and greenish flowers in compound racemes (in our species), terminating the branches. — Gen. 270; Gray, Gen. ii. 185, pl. 170; Benth. & Hook. Gen. i. 364.

1. C. SCANDENS, L. — Glabrous; leaves more or less two-ranked from torsion of the stem, ovate to ovate-lanceolate or occasionally obovate,

acute at base, taper-pointed, low-serrate or crenate-serrate, the teeth mostly with incurved points; pedicels articulated below the middle.—Sp. (1753), 196; Watson, Index, 161.—Borders of woods, fence-rows, &c., Canada to North Carolina, west to Minnesota, Kansas, and New Mexico.

MAYTENUS, MOLINA.—Shrub or small tree with coriaceous entire leaves and small flowers solitary or clustered in their axils.—Storia Nat. Chili, 152; Benth. & Hook. Gen. i. 364.

1. M. PHYLLANTHOIDES, BENTH.—Glabrous; leaves thick, dull, short-petioled, abovate-cuneate or cuneate-spatulate, rounded or emarginate at apex; flowers very short-stalked; fruit contracted at base or substipitate. —Bot. Sulphur (1844), 54; Watson, 162.—Florida Keys. Also found in Lower California, on the Rio Grande, in Mexico, &c.

MYGINDA, L.—Shrubs or small trees with mostly coriaceous leaves and small flowers in axillary cymes.—Gen. 178; Benth. & Hook. Gen. i. 366.

* Style slender, at length somewhat unilateral; drupe obovoid, seed erect.

+ Leaves spinose-toothed.

1. M. ILICIFOLIA, LAM.—A foot or two high, downy or glabrate; leaves half an inch long, round-ovate, pungently dentate-serrate and pointed, contracted to a very short petiole; inflorescence shorter than the leaves, the reddish flowers on slender ascending pedicels; drupe 4 to 6 mm. long, 1-celled.—Dict. iv. (1797), 396; Watson, 162.—Southern Florida and the Florida Keys.

+ + Leaves not at all pungent.

2. M. RHACOMA, SWARTZ.—Small shrub, glabrate or slightly downy; leaves rather thin, under an inch long, obovate or elliptical-obovate, obtuse or emarginate, sometimes mucronate, tapering to a short petiole, low crenate-serrate; inflorescence half or two-thirds as long as the leaves, the dark red flowers on slender ascending pedicels; drupe 6 mm. long, one-celled.—Fl. Ind. Occ. i. (1797), 340; Watson, Index, 163. *Rhacoma crossopetalum*. L. Amoen. v. (1760), 393.—Florida Keys.

3. M. PALLENS, SMITH.—Arborescent, glabrous or glabrate; leaves as in the last or more ovate and often somewhat narrowed to the apex; inflorescence nearly as long as the leaves, the red flowers on slender ascending pedicels; drupe 4 to 6 mm. long, 2-celled.—Rees, Cycl. xxv. No. 4, fide DC. Prodr. ii. 13; Chapman, Suppl. 612; Watson, 460; Sargent, Forest Trees, 38. *M. arborea*, Shuttl. No. 121.—Florida Keys.—Teratological specimens appear to be rather common, with the inflorescence densely compound and many flowers replaced by cones of imbricated scales, apparently the result of insect attacks.

* * Stigma sessile and terminal; drupe spheroidal; seed suspended.

4. M. INTEGRIFOLIA, LAM.—Shrub, glabrous throughout, pale; leaves thick, inch and a half long, elliptical-obovate, somewhat narrowed above, obtuse, tapering to a short petiole, entire but with a few rudimentary denticles along the margin; inflorescence not over half the length of the leaves, the lateral pedicels stout and divergent; flowers greenish-white; drupe 4 to 6 mm. long, 1-celled.—Dict. iv. (1797), 396.—Key West.

5. M. LATIFOLIA, SWARTZ.—Rather large shrub, glabrous; leaves thick, inch or inch and a half long, obovate-cuneate, petioled, rounded at apex, crenulate to subentire; inflorescence often nearly as long as the leaves; flowers white; drupe 6 to 8 mm. long, oblong-spheroidal, 2-celled. Fl. Ind. Occ. i. (1797), 342; Watson, 162.—Florida Keys and Guadeloupe.

SCHAEFFERIA, JACQ.—Shrubs or small trees with firm glabrous leaves and small flowers clustered in their axils.—Stirp. Amer. 259; Benth. & Hook. Gen. i. 367.

1. S. CUNEIFOLIA, GRAY.—Shrub with rigid somewhat spinescent twigs; leaves coriaceous, half inch long, spatulate-cuneate, subsessile, rounded or emarginate at apex, entire or occasionally slightly crenate-lobed above, rugose-veiny; flowers sessile; fruit 4 mm. long and about as broad, flattened, with a longitudinal groove on each side.—Pl. Wright, i. (1852), 35; ii. 29; Watson, 163.—Texas and New Mexico, extending into Mexico.

2. S. FRUTESCENS, JACQ.—Small tree with less rigid twigs; leaves larger (2 in. long), elliptical to obovate, mostly very acute at both ends, entire, rugose-veiny; flowers pedicelled; drupe about as large as in the last but less compressed and grooved.—Stirp. Am. (1763), 259; Watson, 163; Sargent, Forest Trees, 39.—Southern Florida and the Keys, from the West Indies.

MORTONIA, GRAY.—Shrubs with small crowded thick entire leaves and small flowers thyrsoidally clustered at the ends of the branches.—Pl. Wright, i. 34, pl. 4; ii. 28; Benth. & Hook. Gen. i. 368.

1. M. SEMPERVIRENS, GRAY.—Twigs and inflorescence pubescent; leaves small (4 to 6 mm. long), smooth and glabrous, elliptical, obtuse to subacute, very short-petioled; pedicels bibracteate close to the flowers, the bracts obtuse; fruit oblong, 2 × 6 mm.—Pl. Wright, i. (1852), *l. c.*; Watson, 162.—Texas and New Mexico (*Wright*).

2. M. SCABRELLA, GRAY.—Pubescent; leaves often twice as large, elliptical or round-elliptical, obtuse or stout-pointed, papillate-roughened; otherwise resembling the last.—Pl. Wright, ii. (1853), 28; Watson, 162.—Arizona and New Mexico, extending into Mexico.

3. M. GREGGII, GRAY.—Twigs and inflorescence pubescent, leaves longer (half inch to inch long), spatulate to oblong, tapering to a short

petiole, mucronate or acuminate, glabrous; bracts acute; fruit shorter and thicker.—Pl. Wright. i. (1852), 35; Watson, 162, 460; Proc. Amer. Acad. xvii. 336.—A Mexican species, extending into Texas.

HIPPOCRATEA, L.—Climbing shrub with prehensile twigs, ample crenate leaves, and rather small flowers in loose dichotomous axillary cymes.—Gen. 363; Benth. & Hook. Gen. i. 369; Peyritsch, in Fl Brasil. Fasc. 75.

1. H. OVATA, LAM.—Leaves thin, elliptical-ovate, obtuse or blunt-pointed, low-crenate with a slender appressed deciduous denticle at each sinus, short-petioled, glabrous; inflorescence somewhat rusty-pubescent; flowers almost sessile; petals rather hairy; valves of capsule an inch and a half long, elliptical, obtuse, closely parallel-veined.—Illust. i. (1791), 100, pl. 28.—Everglades of Florida, climbing over mangroves (*Curtiss*, No. 474*).

CONTRIBUTIONS FROM THE SHAW SCHOOL OF BOTANY.

No. 6.

North American Rhamnaceæ.

By William Trelease.

Presented Apr. 15, 1889.

I am indebted to Mr. Watson, Dr. Vasey, Dr. Britton, Mrs. Curran, Mr. Martindale, and Captain J. D. Smith, for the privilege of using the large collections which they own or control, in the study of this Order, begun two years ago. More recently, I have been permitted to look through the herbaria of Kew Gardens, the British Museum, Berlin, and Copenhagen, where some additional light has been obtained. Specimens clearing up doubtful points, or indicating erroneous conclusions, are requested, and will be gratefully received.

According to Bentham & Hooker (Gen. i. 372), there are about 430 species of Rhamnaceæ, distributed through the temperate and warmer parts of both the Old and New World. Durand (Index Gen. Phanerog. 68) has since increased the number of seemingly good species to about 475. Torrey and Gray (Fl. N. Am. 1838, i. 259) describe 34 species from our region. Watson (Bibl. Index, i. 163) enumerates 47 as belonging to our flora.

With the exception of *Rhamnus cathartica*, which has escaped from cultivation, our species are peculiarly American, either belonging exclusively to our flora, or extending on the one hand into that of northern Mexico, and on the other into the tropical Gulf region.

The Rhamnaceæ, as arranged by Bentham and Hooker (Gen. i. p. xi.), belong in the Cohort Celastrales, of discifloral Polypetalæ, which (for our flora) also includes the Celastraceæ and Ampelideæ (or Vitaceæ). All, so far as we are concerned, are woody plants with small flowers having a rather prominent receptacular disk, under or at the margin of which the stamens are inserted, and (excepting some Celastraceæ) one or two basi-fixed ovules with a ventral raphe, for each carpel. The Rhamnaceæ differ from both of the other Orders in their valvate calyx, the lobes of which are mostly keeled or crested within, and in having their stamens alternate with these, hence opposite (and usually clasped by) the petals when they are present. From most of our Celastraceæ they also differ in the uniform absence of an aril; and from the Ampelideæ, in their drupaceous or dehiscent fruit, relatively larger embryo, and in never producing compound leaves, nor tendrils opposite the leaves.

In most species of Rhamnaceæ the flowers are hermaphrodite. Exceptions are found in *Gouania* and one section of *Rhamnus*, where, by suppression of stamens or pistil, they become essentially diœcious as in *Euonymus*, *Ilex*, *Acer*, etc. Mr. Darwin has called attention to the curious differences in length of the pistil in the diœcious *Rhamnus cathartica*, which bears long- and short-styled staminate, and long- and short-styled pistillate flowers. This unexplained differentiation apparently dates back to a time anterior to the separation of the sexes by abortion of one or the other of them. Long- and short-styled flowers of *R. lanceolata*—first carefully observed, I believe, by Professor Porter—are described by Dr. Gray.* Our species of *Rhamnus* of the hermaphrodite section *Frangula*, are likely to prove protandrous, like the European *R. Frangula*† and *Paliurus aculeatus*. The variability of *R. crocea* in the presence or absence of petals, is to be compared with that noted by Mueller for *R. pumila*,‡ though it may not be explicable on the same grounds. So far as our flora is concerned, the entire Order seems to be adapted to pollination by small Hymenoptera, Coleoptera, and Diptera, but observations on this point are wanting.

A climbing habit has been acquired in *Berchemia* and *Gouania*, the former twining, the latter having twig-tendrils.

Dissemination by birds is apparently provided for in those

* Darwin: Different Forms of Flowers.—Index.

† Mueller: Befruchtung der Blumen, 152.

‡ Alpenblumen, 169.

species with really fleshy fruits. Huth* has a short note on *R. Frangula* in this connection, but I cannot place my hand on observations upon our American species. The widely dehiscent cocci of some species of *Rhamnus* pave the way for the elastic dehiscence of those of *Ceanothus* and *Colubrina*, in which the fruit soon becomes dry and the seeds are expelled with considerable force.† The seeds of *Gouania* are rendered 2-winged by the attached pericarp, each wing consisting of half of one of the prominences originally developed over each septum.

The seed-characters of *Rhamnus*, especially of *R. infectoria*, which furnishes a dye-stuff, have recently been discussed at length by Marshall Ward, and Dunlop.‡

SYNOPSIS.

TRIBE I. ZIZYPHEÆ.—Lobes of calyx deciduous (except in some species of *Condalia*); disk lining the shallow calyx-tube, nearly or quite free from the ovary; fruit mostly fleshy and edible, with a single 1- to 4-celled stone enclosing as many seeds or 1-seeded by abortion.

* Embryo relatively large; albumen not ruminated.

+ A single ovule to each carpel.

++ Apetalous.

1. CONDALIA.—Style somewhat 2- or 3-lobed.

++ ++ Petals present.

2. ZIZYPHUS.—Petals cucullate and clawed; style bifid, flowers umbellately clustered.

3. MICRORHAMNUS.—Petals cucullate and clawed; style notched; flowers solitary; leaves minute, revolute to the broad midrib.

4. BERCHEMIA.—Petals clawless, acute, with incurved margins; style slightly 2-lobed.

+ + Two ovules to each carpel.

5. KARWINSKIA.—Petals cucullate, very short-clawed; style slightly 2- or 3-lobed.

* * Embryo small in the center of copious ruminated albumen.

6. REYNOSIA.—Apetalous; style somewhat 2-lobed.

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* Kosmos, ix. 282. No mention is made of this Order in the more recent paper by this author on Verbreitung der Pflanzen durch die Excremente der Thiere.—Berlin, 1889.

† See Parry: Proc. Davenport Acad. *l. c.*

‡ Annals of Botany, i. 1.

TRIBE II. RHAMNEÆ.—Lobes of calyx deciduous (except in *Sageretia* and one species of *Colubrina*), the mostly shallow tube lined by the disk, or both adhererent to the lower half of the ovary; fruit drupaceous or dry, enclosing 2 to 4 nutlets or cocci.

* Fruit fleshy, free from the calyx.

7. RHAMNUS.—Tube of calyx rather deep; petals small and clawless, sometimes wanting; style notched; cocci sometimes perforate at base; usually tardily dehiscent.

8. SAGERETIA.—Calyx shallow; petals cucullate and clawed; style short, 3-lobed.

* * Fruit dry or nearly so, partly inferior.

9. CEANOTHUS.—Calyx-lobes petaloid; petals cucullate and clawed; style elongated, mostly 3-lobed with spreading divisions; inflorescence usually compound and thyrsoid.

10. COLUBRINA.—Chiefly differing from *Ceanothus* in habit and the collection of its less showy flowers in axillary umbel-like clusters.

TRIBE III. COLLETIEÆ.—Nearly leafless green-stemmed plants; lobes of calyx persistent; disk lining the cup-shaped calyx tube, mostly investing, but free from, the lower half of the ovary; fruit dry, enclosing 3 cocci.

11. ADOLPHIA.—Petals cucullate; cocci perforate at base, dehiscent.

TRIBE IV. GOUANIEÆ.—Lobes of calyx persistent, its tube adherent to the entire surface of the ovary; fruit dry, 3-winged.

12. GOUANIA.—Petals cucullate; fruit separating through the wings into 3 indehiscent, 2-winged segments.

CONDALIA, CAV.—Rigidly branching, mostly spiny shrubs or small trees, with alternate or obliquely opposite pinnately veined leaves, and small flowers solitary or clustered in the axils.—Ann. Hist. Nat. i. 39;* Gray. Gen. ii. 171; Benth. & Hook. Gen. i. 376.—About 6 species, of the warmer parts of America.

* Spinose: leaves alternate, rather small; flowers solitary, or fascicled without a common peduncle; sepals not conspicuously crested, at most tardily deciduous.

1. C. OBOVATA, HOOK.—Small tree, velvety-pubescent or at length glabrate, the somewhat angled twigs with white flaking epidermis; leaves often fascicled, half or three-fourths inch long, petioled, spatulate to

* The first three volumes of this publication (Madrid) bear the title "Annales de Historia Natural," subsequently changed to "Ann. Ciencias Nat.," as quoted by Bentham and Hooker. The copy at the South Kensington branch of the British Museum, which is the only one I have seen, bears date 1799-1800; but the title page of part 1 is dated 1799 with the additional imprint 1829, while part 2 is dated, and with imprint, 1799.

obovate-cuneate, mostly mucronate and entire; flowers few in each axil, very short-stalked; drupe subglobose, about 4 mm. in diameter, the short stout style disarticulating at about the middle; stigma 3-lobed. — Icones. (1840) pl. 287; Watson, Index, 167; Sargent, Forest Trees of N. A. 40 — Texas to Mexico.

2. C. SPATHULATA, GRAY.—Shrub, glabrous or velvety, the twigs with white flaking epidermis or somewhat pruinous-incrusted; leaves less than a half-inch long, short-petioled, spatulate-cuneate, acute to emarginate; pedicels 2 mm. long; drupe obliquely obovoid, 4 mm. long; style slender, slightly 2-lobed, disarticulating near the top. — Pl. Wright (1852), i. 32; Watson, Index, 168. — Southern California, Arizona, and Texas, into Mexico.

3. C. MEXICANA, SCHL. — Shrub, somewhat intermediate between the last two; leaves spatulate-obovate, acuminate; drupe ellipsoidal, 6 mm. long, with a thicker stone. — Linnæa (1842), xv. 471.—Southern Arizona (*Pringle*), from Mexico.

* * Spineless; leaves ample, often obliquely opposite; flowers mostly umbelled, on a short peduncle; segments of calyx triple-crested above.

4. C. FERREA, GRISEB.—Small tree, with somewhat velvety ascending twigs, often rough with crowded lenticels; leaves coriaceous but rather thin, glossy above, mostly inch to inch and a half long, broadly elliptical, emarginate-mucronate, entire or with wavy margins, glabrous except on the petiole and upper surface of midrib; peduncle about 2 mm. long, notched at apex, each branch bearing a few short-stalked flowers, the fruiting pedicels as much as 6 mm. long; drupe globose-ovoid; style short, forked nearly to the middle.—Fl. Brit. W. Ind. (1864), 100; Chapman, Suppl. 612; Sargent, 39. *Scutia ferrea*, Brongn. Ann. Sc. Nat. (1), x. 363; Watson, Index, 170. *Rhamnus ferreus*, Vahl. Symb. (1794), iii. 41, pl. 58.—Southern Florida and Florida Keys, from the West Indies.—If the person who applied the oldest specific name is to be mentioned, this becomes *C. ferrea* (Vahl.) Griseb.

ZIZYPHUS, Juss. — Spiny shrubs with alternate leaves 3-nerved or with their principal veins confluent toward the margin, and small flowers in umbel-like clusters.— Gen. 380; Gray, Gen. ii. 169; Benth. & Hook. i. 375.—About 65 species, chiefly in the warmer parts of Asia and America, ours destitute of the stipular spines which characterize a part of the genus.

* Umbels on a short peduncle; calyx fleshy; drupe beakless, with a thin-walled stone.

1. Z. OBTUSIFOLIA, GRAY.—Rigid and spinose, or, when more luxuriant, slender-branched, somewhat pubescent to glabrate, the angled twigs pruinose incrusted; leaves mostly glabrate, quarter-inch to inch long, typically thin and green, spatulate to elliptical or on long shoots ovate-deltoid, acute to emarginate, entire or the broader forms unequally coarse-serrate or lobed; peduncle and pedicels each about 2 mm. long, mostly

villous, like the calyx; drupe subglobose, about 8 mm. in diameter.—Gen. (1849) ii. 170, pl. 163; Watson, Index. 170. *Rhamnus* (?) *obtusifolius*, Hook. in Torr. & Gr. Fl. (1840), i. 685. *Paliurus Texensis*, Scheele, Linnæa (1848), xxi. 594.—Texas to Mexico.—The broadest leaves, on long shoots, are sometimes nearly 3 inches wide and mostly 3-nerved. The name will be written by some botanists *Z. obtusifolia* (Hook.) Gray.

2. Z. LYCIOIDES, GRAY.—Very rigid and spinose, the striate zig-zag branches mostly velvety and whitened; leaves pale, half-inch long or less, short-petioled, subglabrous, oblong or occasionally ovate, obtuse or emarginate, frequently rounded at base, usually entire; drupes globose or somewhat elongated, about 8 mm. in diameter.—Pl. Lindheimer. (1850) 168; Watson, Index, 170.—New Mexico to Mexico.

VAR. CANESCENS, GRAY.—More hairy, the mostly tomentose 3-ribbed leaves thicker and broader, elliptical to ovate-deltoid, entire to denticulate or somewhat 3-lobed.—Rothrock, Bot. Wheeler (1878), 82.—Arizona to southern California and Lower California.—Intermediate between *Z. lycioides* and *Z. obtusifolia* in its leaf characters, and perhaps distinct.

* * Umbels sessile; segments of calyx thinner and less strongly keeled; drupe beaked, nearly dry, with a thick-walled hard and bony stone.

3. Z. PARRYI, TORREY.—Glabrous throughout, flexuously much-branched and spiny; twigs less sulcate and scarcely incrusted; leaves fascicled, about half-inch long, green, glossy, at length firm, obovate to elliptical, tapering to slender petioles; pedicels very slender, 4 to 6 mm. long; drupe ovoid, about 14 mm. long, the recurved fruiting pedicels of like length.—Bot. Mex. Bound. (1859), 46; Watson, Index, 170; Benth. & Hook. Gen. i. 376.—Southern California.

MICRORHAMNUS, GRAY.—Spiny shrub with fascicled heath-like leaves, and small solitary flowers.—Pl. Wright. i. 33; Benth. & Hook. i. 376.

1. M. ERICOIDES, GRAY.—Minutely puberulent or mostly glabrous; leaves 2 to 6 mm. long, acute, with strongly revolute margins, the enclosed grooves densely short-tomentose; stipules broadly triangular, ciliate; pedicels about 2 mm. long; drupe oblong, 6 to 8 mm. long, the slender style disarticulating from its abruptly pointed summit.—*l. c.* (1852), 34; Watson, Index, 168.—New Mexico to Texas and Mexico.—The only species of the genus.

BERCHEMIA, NECK.—Twining shrub with alternate slender-petioled conspicuously pinnately-veined leaves, and minute flowers in rather loose panicles.—Elem. Bot. ii. 122; Gray, Gen. ii. 173; Benth. & Hook. i. 377.—About a dozen species, in the warm parts of both hemispheres.

1. B. VOLUBILIS, DC.—Glabrous throughout; twigs slender, terete; leaves ample, inch or two long, ovate, acute or narrowly acuminate-cuspidate, with slightly revolute undulate margins; drupe ellipsoidal, about

8 mm. long; style deciduous near the base. — Prodr. (1825), ii. 22; Watson, Index, 163. *Rhamnus volubilis*, L. f. (1781), 152, *fide* DC. *R. scandens*, Hill, Veg. Syst. (1769), xiv. 64. — Virginia to Florida and Texas, climbing over trees to a great height.—The specific name of Hill appears to antedate that employed here and now in general use. Some authors would, therefore, write *B. scandens* (Hill).

KARWINSKIA, Zucc. — Unarmed shrub, with mostly opposite pinnately veined leaves, and small flowers in short peduncled axillary clusters.—Denkschr. Baier. Akad. iv. 349; Benth & Hook. i. 377.

1. K. HUMBOLDTIANA, Zucc. — Twigs more or less puberulent and pruinose; leaves inconspicuously pellucid-punctate and sometimes dark-dotted, mostly glabrate, slender-petioled, 1 to 3 in. long, elliptical-ovate, obtuse to acute or mucronate, rounded or subcordate at base, entire or undulate, the conspicuous mostly simple veins ending in a marginal nerve; peduncle 2 mm. or less long, few-flowered; pedicels of about the same length, both elongating in fruit; drupe ovoid, apiculate, half-inch long; style articulated near the top. — München. Abhandl. (1832), i. 353; Watson, Index, 168.—Mexico and Lower California, extending into Texas and New Mexico.

REYNOSIA, GRISEB. — Unarmed shrubs or small trees, with mostly opposite pinnately veined, very thick and coriaceous evergreen leaves, and small flowers in sessile axillary umbels. — Cat. Pl. Cubens. 33; Eggers, Vidensk. Meddelelser, Copenhagen, 1877, 173, pl. 2.

1. R. LATIFOLIA, Griseb.—Small tree; twigs glabrous or at first slightly puberulent; leaves half-inch to inch and a half long, on short thick petioles, elliptical to spatulate-oblong or obovate, rounded at both ends, emarginate and commonly short-mucronate, entire, with revolute margins; flowers appearing with the new leaves; pedicels about 4 mm. long, increasing to 8 mm.; fruit elliptical, half-inch long, short beaked. — *l. c.* (1866) 34; Gray, Bot. Gaz. iv. 208; Chapman, Suppl. 612; Sargent, Forest Trees, 39. *Rhamnidium revolutum*, Chapm., Suppl. 612 (and in part of Eggers' distributions). — Southern Florida and Florida Keys, from the West Indies. — The leaves of the Cuban type rather shorter, thicker, and more bronzed, than in our plant.

I was unable to find Vahl's type of *Rhamnus lævigatus* (Symb. iii. 41) at Copenhagen, and the evidence that it was this plant seems too slight for even the most ardent reformer of nomenclature to yet venture on restoring Vahl's specific name.

RHAMNIDIUM REVOLUTUM, Gr., of the West Indies, which resembles this species very closely in foliage characters, has petals, and the albumen is not ruminated.

RHAMNUS, L.—Shrubs or small trees, with alternate or more or less opposite pinnately veined leaves, and small flowers in sessile or short-peduncled axillary umbels.—Gen. 265; Gray, Gen. ii. pl. 168; Benth. & Hook. i. 377.—Includes *Frangula*, Tourn. etc.—About 65 species, mostly in the warmer parts of Europe, Asia, and America.

* Flowers mostly polygamo-diœcious, without a common peduncle; seeds more or less deeply grooved down the back (except in *R. alnifolia*), the raphe lying in the groove; cotyledons rather thick, curved with the seed.—§ *Eurhamnus*.

+ Leaves coriaceous, evergreen, often pungently toothed; flowers 4-merous; fruit red; cocci widely dehiscent on the inner angle.

1. R. CROCEA, Nutt.—Spreading shrub with rather red bark, the divaricate puberulent or glabrate twigs forming blunt spines; leaves fascicled or alternate, glossy, the lower surface mostly bronzed, glabrous, or somewhat puberulent on the petiole and midrib below, quarter-inch to 3 in. long, subrotund to broadly ovate or elliptical, emarginate to mucronate-acuminate, glandular-dentate or bidenticulate; flowers mostly (but not always) apetalous; fruit 4 to 6 mm. long, 1- to 3-seeded.—Torr. & Gr. Fl. (1838) i. 261; Watson, Index, 169; Mrs. Curran, Proc. Cal. Acad. 2 ser. i. 251.—California and Arizona.

VAR. PILOSA, Trelease.—Densely pilose throughout; leaves revolute; fruit rather shorter and broader.—Mrs. Curran, *l. c.* (1888).—Mountains of San Diego Co. Cal. (*Palmer*, 1875, No. 38; *Mrs. Curran*).

R. insulus, Kellogg, Proc. Cal. Acad. ii. 20, restored under the name *R. insularis*, by Greene, in Bull. Cal. Acad. ii. 392, with its synonym *R. ilicifolius*, Kellogg, *l. c.* 37, is said by Professor Greene to differ from *R. crocea* in its arboreous habit, gray bark, and larger leaves and fruit, but I cannot clearly make it out in the herbarium.

+ + Leaves thinner, deciduous, never pungently toothed; fruit becoming nearly black.

++ Petals present; flowers mostly 4-merous.

2. R. CATHARTICA, L.—Tall shrub; branchlets glabrous, opposite or obliquely opposite, the longer ending in short abrupt spines; leaves often fascicled on short spurs, inch or two long, slender petioled, more or less hairy on the veins below, broadly elliptical to subovate, obtuse or blunt-pointed, somewhat acute at base, crenulate or serrulate with glandular denticles, some of the larger veins running to the apex; flowers appearing a little later than the leaves, mostly solitary in the lower axils; pedicels glabrous, 6 to 8 mm. long; carpels 3 or 4; groove of seed deep and narrow.—Sp. (1753) 193; Watson, Index, 168.—A hedge-plant, escaping somewhat in the East, in dry places.

3. R. LANCEOLATA, Pursh.—Tall shrub; branchlets puberulent or glabrate, alternate, not spinose; leaves 1 to 3 in. long, short-petioled, golden-pubescent, the upper surface at length glabrate, lanceolate or ovate-lanceolate, obtuse when young, but mostly blunt-acuminate when grown, rounded or tapering at base, serrulate with incurved gland-tipped teeth, pinnately veined; flowers appearing with the leaves, 2 or 3 together in the

lower axils; pedicels 2 to 6 mm. long, at length mostly glabrous; carpels 2; seeds with a broad open groove. — Fl. (1814) i. 166; Watson, Index, 169. — Woodland, etc. Pennsylvania to Missouri, south to Alabama and Texas.—What appears to be this species also collected at Pagosa Springs, Col. (*B. H. Smith*).

++ Petals wanting; flowers 5-merous.

4. R. ALNIFOLIA, L'Her. — Low shrub; branches puberulent, alternate, not spinose; leaves 1 to 4 in. long, short-petioled, soon glabrate except on the veins, ovate or broadly elliptical, obtuse to acuminate, mostly acute at base, irregularly glandular-serrate or biserrate with strongly incurved teeth; flowers appearing nearly with the leaves, solitary or 2 or 3 together in the lower axils; pedicels from 2 to 4 mm. becoming 8 mm. long, glabrate; carpels 3; seed not grooved, and with nearly plane (but thin) cotyledons, in this respect approaching the next section. — Sert. Angl. (1788) 5; Watson, Index, 168; Coulter, Rocky Mt. Bot. 46.—Cold Swamps, New Brunswick to Saskatchawan, Montana and Oregon, south to Pennsylvania, Illinois, and California.

* * Flowers mostly hermaphrodite, appearing after the leaves, in usually peduncled umbels; fruit dark; seeds not grooved, generally notched at base; cotyledons thick and fleshy; stems unarmed; leaves alternate.—§ *Frangula*.

+ Leaves deciduous; flowers 5-merous, puberulent; carpels 3.

5. R. CAROLINIANA, Walt.—Tall shrub or small tree with more or less puberulent twigs; leaves 2 to 5 in. long, on petioles of half or three-fourths in., firm, usually glabrate or somewhat hairy on the veins below, elliptical-oblong to broadly elliptical, acute or acuminate, rather obtuse at base, remotely and obscurely low-serrate or crenulate; peduncle mostly 6 to 8 mm., pedicels 4 to 6 mm. long. — Fl. Carol. (1788) 101; Watson, Index, 169; Sargent, Forest Trees, 40.—Woodlands, etc. New York to Florida, west to Kansas and Texas.

6. R. PURSHIANA, DC. — Small tree with somewhat pubescent twigs; leaves 2 to 6 in. long, on short downy petioles, typically thin and mostly dull, more or less hairy below and on the veins above, broadly elliptical, very obtuse to abruptly blunt-pointed, rounded at base, irregularly and closely serrulate or denticulate and often obscurely crenate; peduncle mostly 8 to 30 mm., and pedicels 4 to 6 mm. long. — Prodr. (1825), ii. 25; Watson, Index, 169; Sargent, Forest Trees, 41; Coulter, Rocky Mt. Bot. 47.—British Columbia, and southward in the mountains to California, Montana, and Texas.

+ + Leaves evergreen, or tardily and mostly incompletely deciduous; flowers 4- or 5-merous; carpels 2 or 3.

7. R. CALIFORNICA, Esch. — Tall shrub with more or less tomentose twigs; leaves 1 to 3 (rarely 4) in. long, on short petioles, mostly somewhat puberulent, rather dull or the lower surface glossy, elliptical-oblong or the smallest obovate, obtuse or acutish, mostly rounded or subcordate

at base, the slightly revolute margin serrulate or denticulate to nearly entire; peduncle mostly 4 to 16 mm., and pedicels 2 to 6 mm. long, like the flowers glabrous or puberulent; nutlets large and commonly not attenuated at base.—Mem. St. Petersb. Acad. (1828), x. 281; Watson, Index, 168; Sargent, Forest Trees, 40; Mrs. Curran, Proc. Cal. Acad. 2 ser. i. 252.—California and Nevada to southern Colorado and Mexico.—In the broad-leaved form distributed and described by Howell as *R. occidentalis*, from Oregon (list of 1887, No. 1105), this species appears to range farther northward than usual, and to approach the preceding. Indeed, some herbarium specimens are hard to place.

VAR. TOMENTELLA, Brew. & Wats.—Rather low and spreading; leaves densely short-tomentose below.—Bot. Calif. (1876) i. 10; Watson, Index, 168; Sargent, *l. c.* 41.—*R. tomentellus*, Benth. Pl. Hartweg. (1846), 303.—Southern California, Arizona, and New Mexico.

VAR. RUBRA.—Twigs slender, more or less reddish, glabrous; leaves narrowly obovate to mostly oblong or lanceolate, usually acute at base, glabrous or pubescent along the midrib below, deciduous; fruit mostly obovoid, and nutlets attenuated below.—*R. rubra*, Greene, Pittonia (1887), i. 68, 160; Mrs. Curran, under *R. Californica*, *l. c.*—Eastern slope of the Sierra Nevada, in California.—Considering the variability of *R. Californica*, scarcely to be kept up as a distinct species.

SAGERETIA, BRONGN.—Shrubs with rigidly spreading spiny twigs, mostly obliquely opposite pinnately veined glossy leaves, and very small flowers scattered along slender loosely branched axillary and terminal spikes.—Ann. Sci. Nat. x. 359; Gray, Gen. ii. 175; Benth. & Hook., Gen. i. 379.—About a dozen species, mostly of Asia and Java.

1. S. MICHAUXII, Brongn.—Trailing or scrambling; branches finely checked, at length nearly glabrous, twigs somewhat tomentose; leaves commonly inch and a half long, ovate, more or less cordate, acute or acuminate and submucronate, incurved-serrulate; petiole and veins below, somewhat tomentose; inflorescence ample and very loose, leafless above, terminating the upper branches, the lower spikes from the axils of foliage leaves; fruit about 8 mm. long, nearly or quite sessile.—*l. c.* (1826); Watson, Index, 169, and Proc. Amer. Acad. xx. 358. *Rhamnus minutiflorus*, Michx. Fl. (1803) i. 154.—Along the coast, North Carolina to Florida and Alabama. An Arizona specimen (Santa Rita Mts., *Pringle*, 1884, No. 50), though in the range of the next, appears rather to belong here.—If the specific name given by Michaux is to be retained, the plant becomes *S. minutiflora* (Michaux).

2. S. WRIGHTII, Watson.—Spreading shrub 2 to 5 ft. high, slenderer than the last; leaves 6 to 16 mm. long, elliptical to obovate, cuneate, entire or serrulate; inflorescence small and inconspicuous, the few axillary spikes seldom exceeding the leaves.—Proc. Am. Acad. (1885). xx. 358.—New Mexico (*Wright*) to Texas (*Havard*).

CEANOTHUS, L.—Shrubs, or occasionally arborescent, spinose or unarmed, with alternate or opposite pinnately veined or 3-nerved leaves, and small but showy white or blue flowers in often long-peduncled and dense axillary or terminal clusters.—Gen. No. 267; Gray, Gen. ii. 181, pl. 169; Benth. & Hook., Gen. i. 378; Watson, Proc. Amer. Acad. x. 333; Trelease, Proc. Calif. Acad. 2 ser. i. 106; Parry, Proc. Davenport Acad. v. 162.

This exclusively North American genus is represented in Mexico by 3 well-marked species, our flora including, according to my opinion when my preliminary synoptical list was published, 32 species. Dr. Parry, reducing some of these, and adding several others, makes 30 for our region.

COLUBRINA, RICHARD.—Shrubs or trees, with rigidly divaricate but scarcely spinose branches, alternate pinnately veined or 3-nerved leaves, and tomentose flowers in axillary umbel-like clusters.—Brongn. Ann. Sc. Nat. x. 368; Grisebach, Fl. Brit. W. Ind. 100; Benth. & Hook. Gen. i. 379.—About 10 species, belonging to the warmer parts of America, with a single exception.

* Leaves usually rather small, somewhat toothed (at least some of them), more or less 3-nerved; common peduncle very short or wanting; calyx segments tardily and incompletely deciduous; fruit short-beaked by the persistent style.

1. C. TEXENSIS, Gray.—Shrub as much as 15 ft. high; branches mostly rigidly divaricate, terete, gray-tomentose or soon glabrate and glaucous; leaves usually less than 1 in. long, pubescent or ultimately glabrate, elliptical to spatulate-obovate, subcuneate to more or less rounded at base, obtuse to acute or mucronate, glandular-denticulate; fruit 8 mm. in diameter, the recurved pedicels of equal or greater length.—Pl. Lindheimer. (1850), 169: Watson, Index, 167. *Rhamnus* (?) *Texensis*, Torr. & Gr., Fl. (1838) i. 263. *Condalia obovata*, Gray, Hall, Pl. Tex. 5!—Texas and Mexico.—In one of Lindheimer's specimens, and in Drummond Nos. 67 and 652, the leaves are broadly oval and as much as 2 in. long.—A citation of double authority makes *C. Texensis* (Torr. & Gr.) Gray.

* * Leaves ample, entire, not at all 3-nerved; common peduncle evident; calyx segments soon falling; styles deciduous at base.

2. C. RECLINATA, Brongn.—Large tree, the old trunks deeply fissured: twigs less divaricate, sulcate, soon glabrous, with numerous small lenticels; leaves slender-petioled, inch and a half to 3 in. long, at length glabrate, elliptical or ovate to lanceolate, mostly blunt-acuminate, with a few conspicuous submarginal (nectar?) glands; inflorescence becoming glabrous; fruit 6 to 8 mm. in diameter, on pedicels of equal or greater length. —*l. c.* (1826) 369; Sargent, Forest Trees, 41. *Ceanothus reclinatus*, L'Her, Sert. (1788), 6. *Rhamnus ellipticus*, Ait. Hort. Kew. (1789) i. 265. *Zizyphus Domingensis*, Nouv. Duhamel (1806), iii. 56.—South Florida, especially on Umbrella Key, from the West Indies.—The name may be written by some *C. reclinata* (L'Her.) Brongn.

3. C. FERRUGINOSA, Brongn.—Shrub or small tree at first densely red-tomentose; twigs nearly terete, with fewer lenticels; leaves stout-petioled, somewhat glossy above. 1 to 4 in. long, elliptical to ovate-lanceolate, obtuse or blunt-pointed, the lower surface with a number of conspicuous scattered (nectar?) glands; cymes dense, becoming somewhat racemose; fruit 6 to 8 mm. in diameter, more clustered than in our other species.—*l.c.* (1826) 369; Watson, Index, 167. *Rhamnus Colubrinus*, L., Sp. 2 ed. (1762), 195.—Southern Florida and Florida Keys, from the West Indies.

ADOLPHIA, MEISN.—Small-leaved or nearly leafless shrubs, with opposite divaricate green branches articulated with the stem and ending in spines, and small flowers in sparse axillary clusters.—Gen. pl. 70; Benth. & Hook. Gen. i. 384.—Contains only our species.

1. A. INFESTA, Meisn.—Mostly puberulent or villous, with often reflexed short hairs; leaves short-petioled, 2 to 10 mm. long, 1-nerved, sparingly hairy below, sublanceolate, acute or mucronate, entire or low-serrate; fruit subglobose, crowned with a beak 1 mm. long, formed by the persistent base of the style.—*l.c.* (1837); Watson, Proc. Am. Acad. xi. 126. and Index, 163.—Arizona and New Mexico, from Mexico.—In 1825, three specific names appear to have been given this plant, viz.: *Ceanothus infestus*, HBK. Nov. Gen. vii. 61; *Colletia*(?) *multiflora*, DC. Prod. ii. 29: and C.(?) *disperma*, DC. *l.c.* Adopting the one in general use, the name might be written *A. infesta* (HBK.) Meisn.

2. A. CALIFORNICA, Watson.—Upper branches often more virgate and less spinose; leaves rather longer-petioled and more pubescent, spatulate to obovate, mostly mucronate and entire; fruit beakless, the style deciduous close to the ovary; otherwise resembling the last.—*l.c.* (1876), and Index, 460.—Southern California.

Incomplete specimens of a plant with more virgate, striate branches, not articulated, which have been collected in Arizona (*Parish*, No. 770), may prove to belong to some southern species of *Retanilla* or *Colletia*. Material is much desired.

GOUANIA, L.—Shrub, climbing by twig-tendrils, with alternate coarsely serrate often 3-nerved leaves, and small polygamo-diœcious flowers loosely fascicled along the slender naked ends of the spreading branches.—Gen. No. 1157; Benth. & Hook. Gen. i. 385.—About 30 species, largely of tropical America.

1. G. DOMINGENSIS, L.—Branches fluted, loosely hairy to glabrate; leaves short-petioled, 1 to 3 in. long, becoming glabrous, or persistently hairy along the veins, ovate, narrowly acuminate, subcordate, the blunt teeth commonly ending in cup-shaped (nectar?) glands; inflorescence tomentose; fruit glabrous, about 6 mm. long and 8 broad (including the wings), notched at top and bottom, when partly grown resembling somewhat that of *Vaccinium*.—Sp. 2 ed. (1763), 1663; Watson, Index, 168.—Southern Florida and the Keys, West Indies, etc., to Brazil.

Contribution to the Chemistry of Combustion.

By C. Luedeking, Ph.D.

The ordinary combustion of organic substances in atmospheric air produces as final products carbon dioxide and water, and also gaseous nitrogen if the substance be nitrogenous. These are the products of combustion of alcohol, coal oil, coal gas, wood, etc. In the course of certain experiments on Titanic acid, it was noticed that in the inner part of the Bunsen flame made just slightly luminous by properly regulating the air supply, the well known cyanogen Titanium compound, so often found in iron blast furnaces when titaniferous iron ores are smelted, was readily formed. By its characteristic appearance, in fact, it is possible by this means to detect or confirm quickly very minute quantities of Titanic acid. The manner of procedure is to dissolve in a small quantity of carbonate of soda, on the loop of a platinum wire, the precipitate or substance in question, and volatilize all the alkali in the inner flame, when the copper-red cyanogen Titanium compound will be formed if Titanium be present. The entire test requires but very little substance, only a few minutes' time, and is exceedingly delicate.

I employed this test in a reverse manner, viz., to discover the presence of cyanogen in various flames. Herein I was perfectly successful in most different cases. The copper-red compound was formed in the flame of a tallow candle, paraffin candle, coal-oil lamp flame, and alcohol flame. It was evident, therefore, that in all the above-named flames cyanogen is formed and bound by the Titanium. Is Titanium now the inducing agent so that cyanogen does not ordinarily exist in these flames? This question is quite justified in view of the following experiments.

Bunsen & Playfair (Journ. f. prakt. Chem., vol. XLII. p. 397) showed that carbonate of Potassium, intimately mixed with Carbon and heated in a current of Nitrogen to the reduction temperature of Potassium, is completely converted into cyanide of Potassium. This, and not the nitrogen of the nitrogenous fuel is the mode of formation of cyanide of Potassium in iron blast furnaces, as was demonstrated by the same authors.

By passing ammonia gas over red-hot charcoal cyanide of Ammonium and Hydrogen are formed, according to Langlois, thus:

$$2NH_3 \times C = NH_4\,CN \times 2H.$$

Here Hydrocyanic acid is formed probably by the dissociation of the ammonia and a reaction upon one another of the nascent elements.

Again, the cyanogen Titanium compound is formed by heating Titanic acid and Carbon in an atmosphere of Nitrogen to the temperature of fusion of platinum according to Wöhler and Deville (Annal. d. Chem. u. Pharm. vol. ciii. p. 231).

Here, then, we have an experiment under conditions similar to those in our own. In the reducing flame we have nitrogen of the atmosphere, free carbon shown by the luminosity, and Titanic acid and a very high temperature. The formation of the cyanogen Titanium compound in the reducing flame is brought about chemically in exactly the same manner as in the Wöhler & Deville experiment.

The general assumption is that Carbon and Nitrogen cannot unite directly without the inducing action of another substance. On the basis of the mechanical data we should also expect this to be the case. The heat of formation of Cyanogen gas out of Carbon (Diamond) and Nitrogen is −38300 calorics. The heat of formation of Hydrocyanic acid out of Carbon (Diamond) and Nitrogen and Hydrogen is −30200 calorics. The heat of formation of Cyanide of Potassium solid out of Carbon (Diamond) and Nitrogen and Potassium is +30300 calorics. Whilst the formations of Cyanogen and Hydrocyanic acid are accompanied with a disappearance of heat, are endothermic reactions, the formation of Cyanide of Potassium is accompanied with powerful evolution of heat, it is an exothermic reaction.

There is, however, one experiment by Morren, C. R. 48, p. 342, demonstrating the direct union of carbon and nitrogen, in passing electric sparks between electrodes of carbon in an atmosphere of nitrogen. The reasons for this result, so antagonistic to thermochemical expectations, we shall enter upon later.

As it was possible to form the cyanogen Titanium compound in the reducing flame of various combustibles, it seems desirable to ascertain whether the presence of Cyanogen or Hydrocyanic acid could be demonstrated in these same flames under conditions precluding the presence of an inducing agent. It was attempted to ascertain whether Cyanogen or Hydrocyanic acid occur in these flames due to the direct action of atmospheric nitrogen, or, in other words, whether atmospheric nitrogen plays a role chemically in the ordinary process of combustion of carbon compounds.

For this purpose the gases of the reducing flame were tapped, as in the ordinary lecture of experiment, to show the combustible nature of the gases in the flame of a candle. However, since glass is dissociated to a great extent, and the alkali metals volatilized under such conditions, and as these are inducing agents for formation of cyanogen compounds, and as these were to be entirely eliminated, a platinum tube was taken. This was mounted in a glass tube for conducting the gases. It was 90 mm. long and 5 mm. in diameter, and of very thin platinum. The gases were conducted into a test tube containing a few cubic centimetres of caustic soda solution, and the end of the gas-conducting tube made to closely approach the surface of the liquid without being obstructed. This mode of experiment was found to give results only. When the gases were made to actually bubble through the caustic soda: no reactions could be obtained. The reason is obvious, for the gases contain such large amounts of Carbon dioxide that any Cyanogen or Hydrocyanic acid is displaced from solution, or, in other words, it cannot accumulate.

The time of combustion necessary before one can obtain a precipitate of prussian blue, in the well known manner in the test-tube liquid, is about one hour. When coal oil or candles are experimented with, the platinum tube must frequently be cleared of soot, and the caustic soda must be filtered for the same reason, before the tests can be made. In much less time, however, one can obtain the reaction as indicated by the green color of the liquid, the prussian blue remaining in solution on account of its minuteness of quantity. I will also say that never was it possible for me in one hour to obtain an immediate precipitate; but only so after several hours' standing of the intensely green liquid.

Considering the ease with which the Cyanogen Titanium reaction can be obtained in the same flames in a few minutes' time, it may seem strange that the prussian-blue reactions are not stronger. However, the conditions of experiment are of necessity very unfavorable. As it is, only a part of the Cyanogen or Hydrocyanic acid is absorbed, the greater quantity being carried away by the current of Carbon dioxide.

The best way of experimenting is to cool the test tube with ice and thus condense most of the aqueous vapor of the gases; much of the Cyanogen can thus be retained.

By this mode of experiment a prussian-blue reaction could be obtained in the combustion of coal gas, various candles, and alcohol.

It is necessary to guard carefully against ammonia in the atmosphere, as otherwise we have an inducing agent for the formation of cyanogen.

We proved then, firstly, that in the combustion of ordinary fuels Cyanogen occurs in the reducing flame, being generated by the process of combustion.

The final answer to our proposition can, however, not yet be given: for, is it not possible that the combustibles referred to above contain Nitrogen? If so, we have an inducing agent; for by our mode of experiment both nitro and amido compounds mixed with alcohol were found to produce large amounts of Cyanogen in their combustion, and consequently it need not be atmospheric nitrogen that causes the formation of Cyanogen or Hydrocyanic acid in our experiments.

Coal gas we know contains nitrogenous compounds, and of tallow we should also expect the same, as well as of alcohol, for in alcoholic fermentation volatile nitrogenous bases are formed. We should least expect paraffin to contain Nitrogen, but cannot positively say.

It was necessary, therefore, to prepare a combustible entirely and certainly free from all nitrogenous matter.

Marsh gas is such a combustible. I prepared 50 litres of this substance out of pure acetate of soda, and lime and soda, previously heated. This Marsh gas was passed from a copper gasometer through a Bunsen burner placed under a bell-jar, and the experiment conducted as in previous cases. The air for combustion was thoroughly purified by passing through several towers of sulphuric acid and lime before reaching the combustible.

The reaction for Cyanogen was very pronounced: a splendid precipitate of prussian blue was obtained quite easily. The time of combustion of the 50 litres of Marsh gas was little over an hour. In this experiment we have positively the answer to our inquiry, "whether atmospheric Nitrogen plays a role chemically in the combustion of Carbon compounds?" All inducing agents for formation of Cyanogen were scrupulously excluded.

We conclude, then, that nitrogen of the atmosphere takes part chemically, generally, in the combustion of carbon compounds forming transiently Cyanogen or Hydrocyanic acid. In other words, we affirm with Morren that Carbon and Nitrogen can unite directly at very high temperatures. Together with a great preponderance of exothermic compounds, we have formed an endothermic compound. This is the general rule in the formation of endothermic compounds. I mention only the formation of Chlorate of Potash.

The reason of the formation of this endothermic compound in the case of combustion may, I think, be found in the most probable fact that we have atoms and not molecules reacting upon one another. When the compound is broken up, there is a certain time when carbon must be in the nascent or atomic state. What its affinities are there we may judge from analogy. It is not impossible that the formation of cyanogen is under such circumstances really exothermic. The heat of dissociation of the carbon molecule is, according to Thomsen, 39610 calorics; so that we see that atomic carbon forming cyanogen would cause an evolution of about 9000 calorics, and would under the circumstances be exothermic.

We may presume, also, that in Morren's experiment the molecules of carbon and nitrogen are dissociated previous to actual combination.

The Hydration of Colloids.

By C. Luedeking, Ph. D.

I.—On the vapor tensions and boiling-points of Solutions of Colloids.

In a work that Prof. Wiedemann and I published recently "On the heats of hydration of certain Colloids," we determined that the vapor tensions of solutions of gelatine are less than that of water at 40° C. This isolated experiment went only to show that the facts were really as our experiments on heats of hydration would lead us to expect them. When gelatine takes up water it actually becomes chemically hydrated, and holds this water with an affinity whose intensity is indicated by our work. It is, therefore, held fast by the gelatine so that the vapor tension is less than for pure water. Our results led us to doubt the correctness of Guthrie's observations on the boiling-points of solutions of Gum Arabic and of Gelatine, published in Phil. Mag. for Sept., '76. Guthrie says that a 40 p. ct. solution of Gum Arabic boils at 98° C. and that a 45 p. ct. solution of Gelatine boils at 97°.5 C. These results are not in accordance with what we should be led to expect from our thermo-chemical observations. We should expect, as did also Guthrie, that the boiling-points of these solutions are higher than that of water. We should expect this also from the fact of their being tenacious liquids.

It was determined, therefore, to investigate the boiling-points and vapor tensions of Colloid hydrates more fully. Experiments were made on Gelatine, Gum Arabic, Gum Tragacanth, Dextrine, Starch, and Agar Agar.

GUM ARABIC.

Pure powdered gum arabic was used. A wide test tube containing a 40 p. ct. solution was subjected to the heat of a water or brine-bath of 103° C. Fragments of platinum were added to facilitate the formation of vapor. At 90°, when in the water-bath, bubbles formed slowly and regularly, and as the temperature rose their number increased until, at 99°.8, the temperature to which the thermometer rose, a constant and rapid evolution of gas was observed. As this did not in character resemble an evolution of steam. an examination was made, and it was found to be due to Carbon Dioxide. When a solution of like strength was placed in the brine-bath the thermometer rose to 100° C. and the phenome non was entirely different. It was then actually boiling. Therefore we conclude that the boiling-point of this solution of Gum Arabic is the same as that of water.

GELATINE.

A 50 p. ct. solution of confectioner's gelatine did not evolve a bubble of vapor when subjected to the heat of a water-bath, although the temperature rose to 99°.8. In a brine-bath, however, the solution did boil, and the thermometer immersed showed a constant temperature of 100° C.

Determinations of vapor tension of the same solution at 100° C. showed it to be less than that of water at the same temperature by 2–3 mm. mercury. Consequently the boiling-point must be slightly above that of water. This is in acordance with theory. Under no circumstances can gelatine solutions boil lower than water. Let us consider that dissociation of the solution does take place at 97° C. The water liberated can only have the tension of water, which at that temperature is less than the barometric pressure, and therefore a phenomenon of boiling cannot be observed.

We need not enter into detail of description concerning experiments on Gum Tragacanth, Agar Agar, Dextrine, and Starch. The results were in every instance the same in character as those obtained for Gum Arabic and Gelatine. They are all in agreement with our thermo-chemical results, and contradictory of Guthrie's results.

II.—The dissociation of Gelatine and Gum Arabic Hydrates at low temperature.

Gelatine hydrates containing 50, 60 and 75 p. ct. of water were cast in cylindrical form, and cavities formed in the axis of each for the reception of thermometers. They were subjected to −18° C. for several hours, when they presented no signs of being frozen. The same hydrates were subjected to the same temperature as above on slides, and examined under the microscope in polarized light. Clusters of ice crystals had segregated from the mass. Our conclusions are that gelatine solutions do not solidify as a whole when subjected to low temperatures, but become partially dissociated. The amount of dissociation is directly proportional to the degree of hydration and the depth of temperature.

These results differ from those of Guthrie, who did not examine the circumstances in polarized light. Only when examined in this way can the process of freezing of colloid hydrates be understood.

III.—Condensation in the process of Hydration.

As we found that by the process of hydration of colloids heat is evolved, we should expect it to be attended by condensation. The densities of gelatine solutions of 50, 25 and 10 p. ct. were determined. The densities of solutions of these strengths were also calculated. Following are the results:

50 per cent. Gel.	sp. gr. found,	1.228	sp. gr. calc.	1.1858	Diff. 0.422
25 " "	" "	1.153	" "	1.0929	" .0601
10 " "	" "	1.064	" "	1.0165	" .0485

We see that the calculated spec. grav. is less than the observed spec. grav. in every instance. In other words, water unites with gelatine with condensation. The first equivalents of water are condensed more than the equivalents bound later. In this respect the hydration of colloids is analogous to the hydration of salts. In the 50 p. ct. gelatine solution, condensation of 0.422 is observed; in the 25 p. ct. gelatine solution, the condensation is .0200; and, finally, in the 10 p. ct. gelatine solution, the condensation is .0054. We see that the force of chemical affinity is like the force of gravitation; it diminishes with the distance. The first equivalents of water are near the center of attraction, the molecule of colloid, and are consequently bound with superior force.

The above is a mere sketch of the work on which we base the results given. The detail would hardly be of interest.

It was our purpose to bring certain physical phenomena attendant on the process of hydration into harmony with one another. The process of hydration is accompanied with evolution of heat.

Where there is evolution of heat in chemical reactions there is necessarily condensation. Our experiments proved this actually to be the case. Again, where there is condensation the substances reacting upon one another must be united more firmly than when each is in the free state. In other words, the vapor tension must be less. This we actually found to be the case also. The phenomena of hydration of colloids are by no means unimportant. A proper understanding of their values is absolutely necessary for a true understanding of the economy of the animal body. As yet there have never been drawn into consideration these factors. Nor can we draw them into calculation until many more investigations of all the colloid hydrations in the animal frame will have been made.

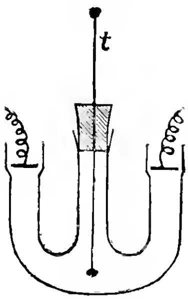
ELECTRICAL CONDUCTIVITY.

In 1883 Prof. E. Wiedemann demonstrated in his experiments on solutions of zinc sulphate in water and glycerine, that the reis no relationship between coefficients of friction and galvanic conduction. For a solution of zinc vitriol in water and glycerin the coefficients of friction were to one another as 1 : 68.7, the resistances of galvanic conduction as 1 : 12.1. In continuation of these experiments I have made, at the instigation of Prof. Wiedmann, an examination of the behavior of zinc vitriol dissolved in gelatine solutions of different strengths at different temperatures. Experiments on the same subject have been published since the time of completion of my work by Arrhenius and B. v. Tietzen-Hennig. However a communication of my resultswill not be superfluous as my experiments were made on much more concentrated solutions of gelatine.

The solutions employed by me contained 25 p. ct. and 50 p. ct. of gelatine, and 2 p. ct., 5.4 p. ct. and 10 p. ct. of zinc vitriol. The mixtures of definite concentrations of zinc vitriol, water and gelatine were made in the following manner:

The gelatine was first weighed out in a beaker glass, and the quantity of water necessary for a certain concentration then added. The solution was boiled in a brine-bath and the necessary amount of salt added. The water lost by evaporation was replaced when the solution was complete. To obtain a 50 p. ct. gelatine solution with 10 p. ct. $ZnSo_4 + 7H_2o$, there were mixed 200 g. of gelatine with 160 g. of water and 40 g. of $ZnSo_4 + 7H_2o$ added when the solution had taken place. Finally, the entire mass was made to weigh 400 g. by adding water.

The galvanic conductivity of each of the six solutions was compared with that of an aqueous solution of the same concentration, which was maintained at a constant temperature. The measurements were made between about 5° and 90° C. A Kohlrausch universal rheometer and a Wiedemann galvanometer were used for this purpose. The current was closed only for a very short time and often reversed in direction. The solutions were contained in vessels of construction given in figure, which is a slight



modification of Kohlrausch, and permits of determining the temperature of the substance under examination by means of the thermometer *t*. This is very desirable in case of such tenacious liquids as solutions of gelatine are, as the temperature does not become equalized in them by convection currents. The apparatus was clamped and held in position in the water-bath by the thermometer.

The following tables contain the results obtained. The figures express the relations of the conductivities of the solutions examined to that of an equally concentrated aqueous solution of 20° C. As electrodes, amalgamated zinc plates were used.

The plates appended to this paper give a graphical representation of the variation of electrical conductivity with temperature.

2 p. ct. Zn. Vitriol in (1) Water; (2) in 25 p. ct Gelatin Sol.; (3) 50 p. ct. in Gel. Sol.

1. *t*.	4	6.5	9	12	13	18	24	32.5	41
k.	0.724	0.782	0.855	0.930	0.953	1.099	1.22	1.45	1.66
2. *t*.	4	9.5	10	13	13.5	16	19	36	53.5
k.	0.461	0.543	0.559	0.625	0.629	0.676	0.724	1.03	1.45
3. *t*.	15	17.5	25	33	34.5	44.5	55	59	63.5
k.	0.142	0.154	0.202	0.251	0.263	0.342	0.444	0.477	0.521

[CONTINUED.]

1. *t*.	48	64.5	77.
k.	1.89	2.27	2.50
2. *t*.	63	72.	90
k.	1 61	1 82	2 13
3. *t*.	69	80.5	88.
k.	0.578	0 685	0 724

5.4 p.ct. Zn. Vitriol in (1) Water; (2) in 10 p.ct. Gelatin Sol.; (3) in 25 p.ct. Gel. Sol.; (4) in 50 p.ct. Gel. Sol.

1. *t*.	5	9	11	18	20	28	35	40	45	50	55	60	65	70	80
k.	0.757	0.877	0.918	1.075	1. 099	1.28	1 47	1.58	1.69	1.77	1.91	1 96	2.10	2.16	2.31
2. *t*.	5	10	11	13	14	15.5	17	20	24	25	28	32	37	42	46
k.	0.562	0.645	0.658	0.714	0.724	0.764	0.807	0.885	0.953	0.970	1.04	1.11	1.20	1.33	1.37
3. *t*.	5	9	11	14.5	17 5	20	26	30.5	40	50	60	69.5	81	90	....
k.	0.305	0.360	0 378	0.420	0.463	0.488	0.600	0.621	0.741	0 893	1.03	1.12	1.22	1·26	...
4. *t*.	5	7	11	14	23	28	31	41	49.5	56	59.5	69	76	79.5	89.5
k.	0.143	0.154	0.182	0.200	0.264	0 303	0.333	0 413	0.485	0.521	0 571	0.649	0.694	0.730	0.782

[CONTINUED.]

.85	90				
2.38	2.40				
.50	.60	.69	.80	.85	90
1.49	1 69	1.85	2 00	2.00	2.04

10 p.ct. Zn. Vitriol in (1) Water; (2) 25 p.ct. in Gel. Sol.: (3) in 50 p.ct. Gel. Sol.

1. *t*	6	10	15	18.5	33	41	47	59	73	80	90	....	....
k.	0 619	0.730	0.847	0.926	1 23	1.39	1.51	1.72	1.92	1.96	2 00	....	....
2. *t*.	5	6	10	15	15.5	19	26	36	46	56	69	76	90
k.	0.303	0.333	0 377	0.431	0 443	0.488	0.568	0.690	0.833	0 962	1.00	1 16	1.26
3. *t*.	15	18	22	30	36	38.5	50	57	60	69	70	79	99
k.	0 129	0.143	0.161	0 187	0 213	0 222	0 286	0.323	0.337	0.391	0.400	0.445	0.476

From these values there are then deduced by graphic interpolation the following for the galvanic conductivity k at 5, 10, 15, 20, 30°, etc. The following table contains these:

t.	2 p.ct. Zn.So_4+$7H_2O$.			5.4 p.c. Zn.So_4+74_2O.				10 p.c. Zn.So_4+74_2O.		
t.	+ Water.	+ 25 p.c. Gel.	+ 50 p.c. Gel.	+ Water.	+ 10 p.c. Gel.	+ 20 p.c. Gel.	+ 50 p.c. Gel.	+ Water.	+ 25 p.c. Gel.	+ 10 p.c. Gel.
5	0·741	0·469	.	0·757	0·562	0·305	0·143	0·617	0·303	...
10	0·869	0·555	....	0·877	0·645	0·368	0·181	0·729	0·378	...
15	0·990	0·653	....	0·990	0·769	0·424	0·207	0·847	0·441	0·129
20	1·111	0·735	0·167	1·111	0·877	0·490	0·239	0·943	0·495	0·151
30	1·351	0·892	0·227	1·316	1·075	0·609	0·322	1·149	0·613	0·188
40	1·666	1 099	0·301	1·562	1·266	0·751	0·405	1·370	0·741	0·227
50	1·923	1·351	0·388	1·818	1·515	0·892	0·493	1·562	0·877	0·287
60	2·174	1·587	0·490	2·000	1·666	1·020	0·575	1·724	1·000	0·338
70	2·381	1·786	0·585	2·174	1·786	1·111	0·654	1·887	1·087	0·400
80	2·500	1·961	0·683	2·272	1·923	1·190	0·735	2·000	1·205	0·446
90	2·572	2·127	0·725	2·381	2·000	1·250	0·787	2·000	1·282	0·476

For the coefficients of change $\alpha = k(_{90} - k_{20})k_{20}$ we have from the above table the following values:

	2 p.ct. Gel. $ZnSO_4 + 7H_2O$.			5.4 p.ct. $ZnSO_4 + 7H_2O$.				10 p.ct. $ZnSO_4 + 7H_2O$.		
	+ Water.	+ 25 p.ct. Gelatin.	+ 50 p.ct. Gelatin.	+ Water.	+ 10 p.ct. Gelatin.	+ 25 p.ct. Gelatin.	+ 50 p.ct. Gelatin.	+ Water.	+ 25 p.ct. Gelatin.	+ 50 p.ct. Gelatin.
α'	1·315	1·894	3·341	1·143	1·280	1·551	2·293	1·121	1·589	2·152

A comparison of the values for zinc vitriol solution in water with those of Beetz* shows a good concordance, as will be seen from the following table:

10 p. ct. $ZnSO_4 + 7H_2O$. Galvanic Conductivity $\times 10^9$.

	Found.	Calculated.
30°	2916	2438
40°	3471	3492
50°	3964	4056
60°	4376	4610
70°	4788	5164
80°	5077	5718

We see that at higher temperatures just as Beetz found the conductivity increases less than corresponds to the formula—

$$Z = (32.09 + 4.0364p - 0.0473p^2)10^9.$$

The figures representing the dependence of the galvanic conductivity upon the temperature show, that at the point of change of the liquid gelatin into the solid state, even for very concentrated solutions, there is no sudden change.

The coefficients of change show that the change of conductivity with temperature is greater in proportion as the concentration of the gelatin solution is greater. But the influence of the addition of gelatin changes with the concentration of the zinc vitriol.

The first result is contrary to that obtained by Arrhenius, that the coefficients of change are independent of the concentration of gelatin. The reason of this contradictory result is to be found in the fact that Arrhenius used only very dilute gelatin solutions.

* Beetz, Wiedemann's Galvanismus, I. p. 328.

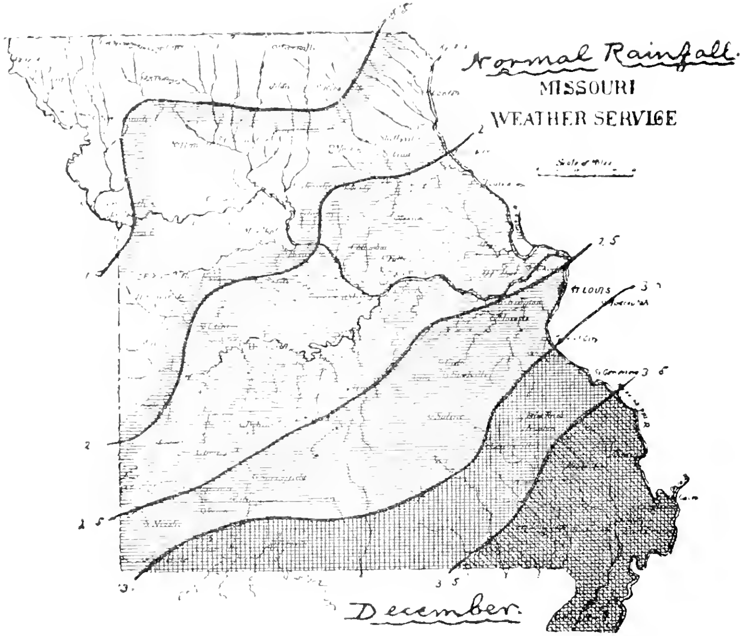
I also examined the velocity of diffusion of the zinc vitriol solutions into gelatin. Similar results to those of B v. Tietzen-Hennig were obtained. However, I have for the present postponed drawing any conclusions from them. We have here a far more complicated phenomenon than would appear on first sight. For not alone does the zinc vitriol diffuse into the water contained in the gelatin, but also water from the zinc vitriol solution. How complicated this phenomenon is will appear from the fact that, if a concentrated zinc vitriol solution is allowed to diffuse into a concentrated gelatin, crystals of zinc vitriol separate out in the upper parts of the gelatin. Before, therefore, we can compare experiments on diffusion with those on electric conductivity numerically, it is necessary to follow these phenomena more closely, and with this I am engaged at present.

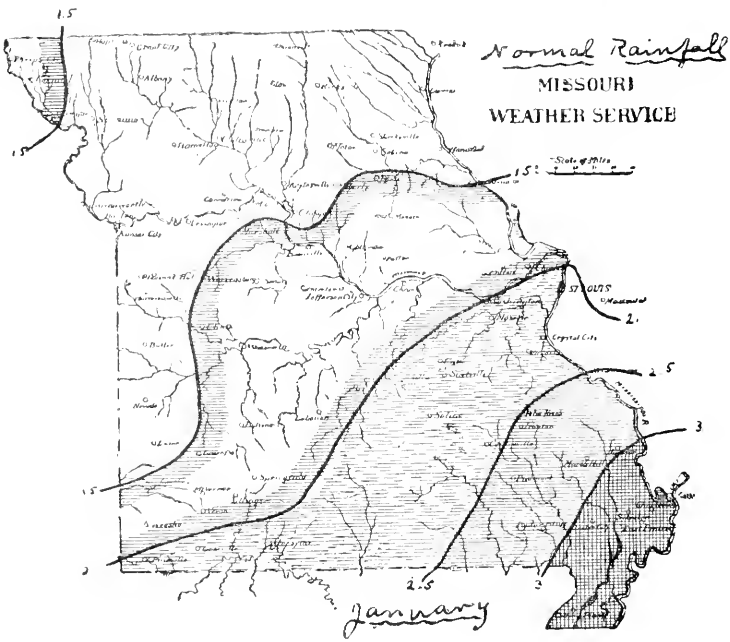
EXPLANATION OF THE PLATES.

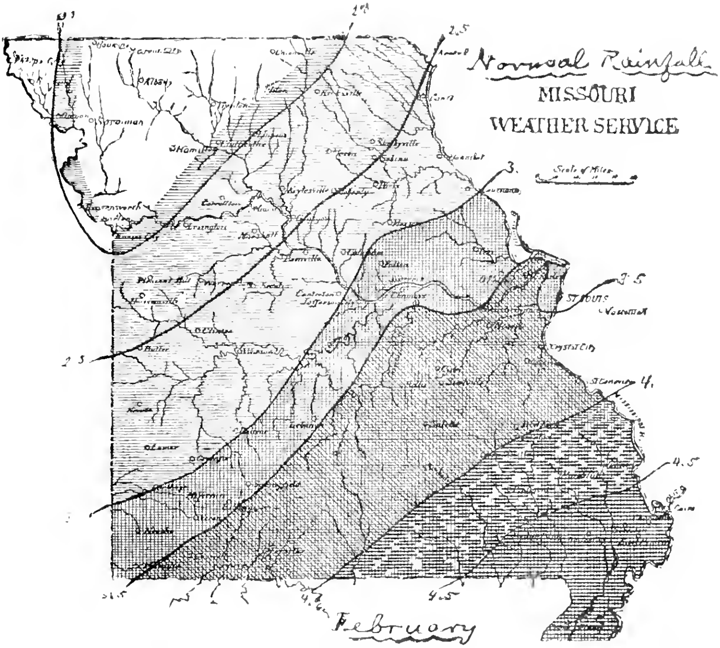
The monthly rain maps give in each case the average rainfall for that month for ten years ending December 31st, 1887.

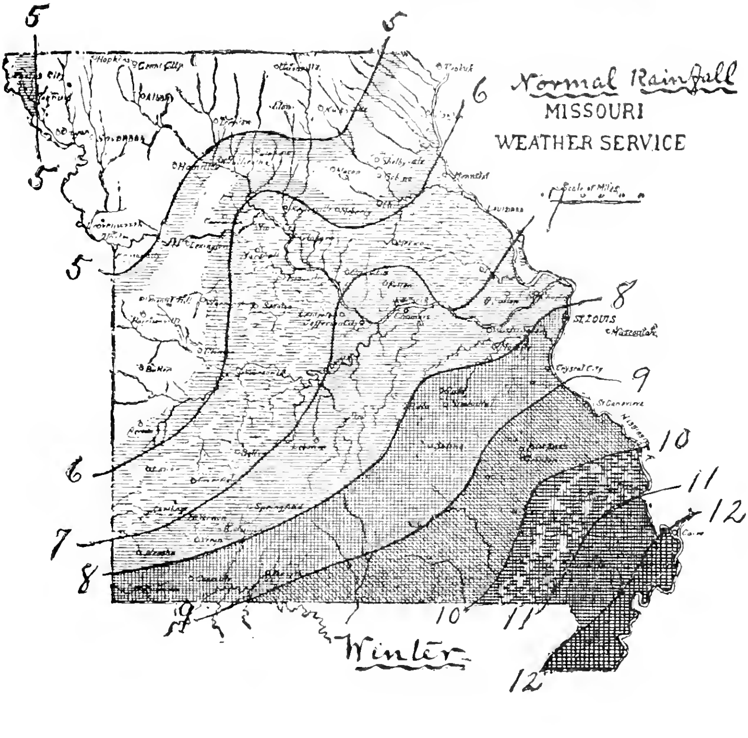
The rainfall is given in inches and tenths. On some of the maps the decimal point was not reproduced in the copper plate.

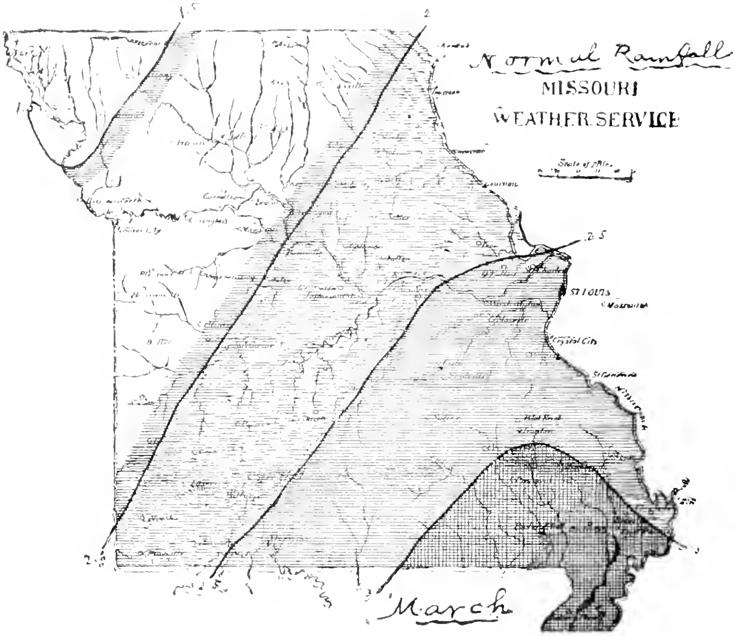
Average monthly values which have been approximated by means of monthly maps are indicated in the tables by asterisks.

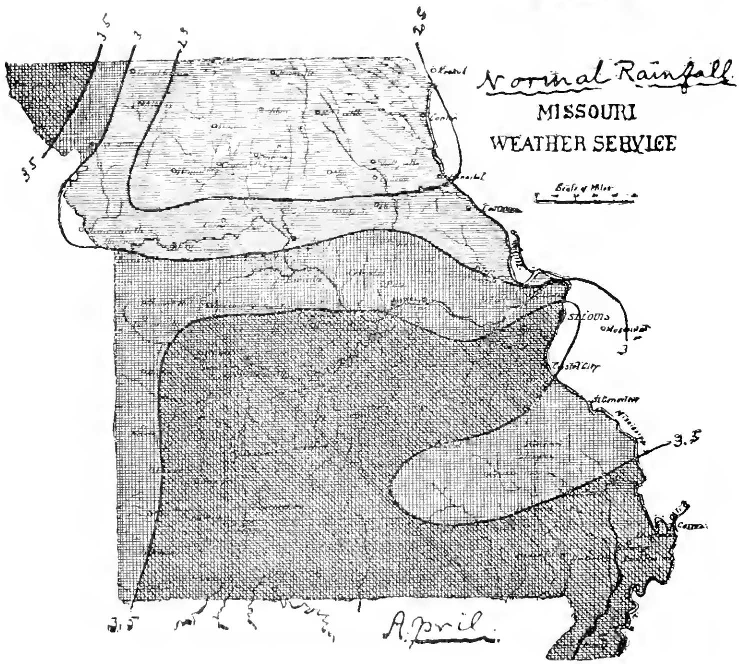

Normal Rainfall.
MISSOURI
WEATHER SERVICE
December.

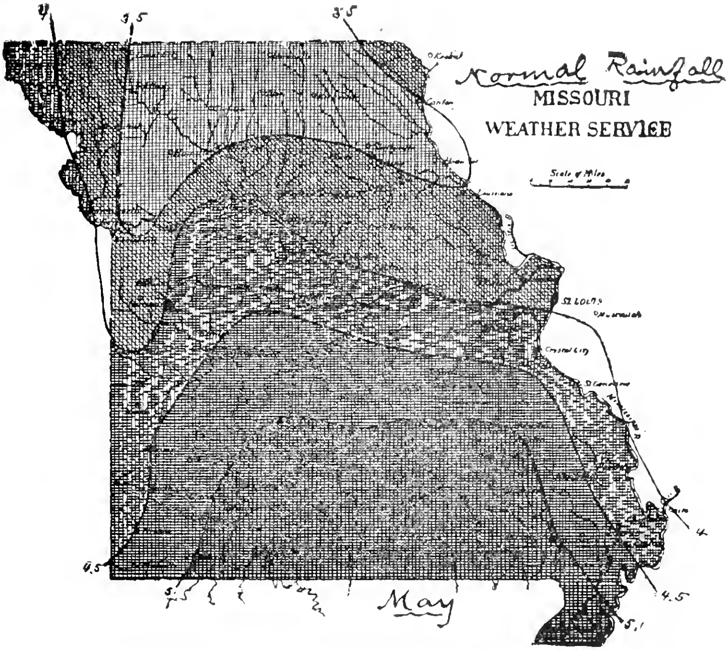

Normal Rainfall
MISSOURI
WEATHER SERVICE
January

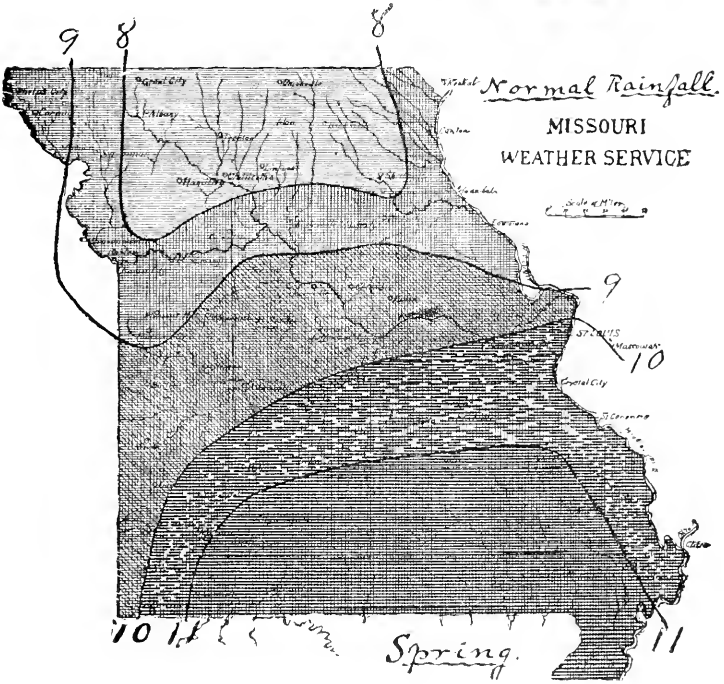

Normal Rainfall
MISSOURI
WEATHER SERVICE
Scale of Miles
2.5
3.
3.5
4.
4.5
ST. LOUIS
February

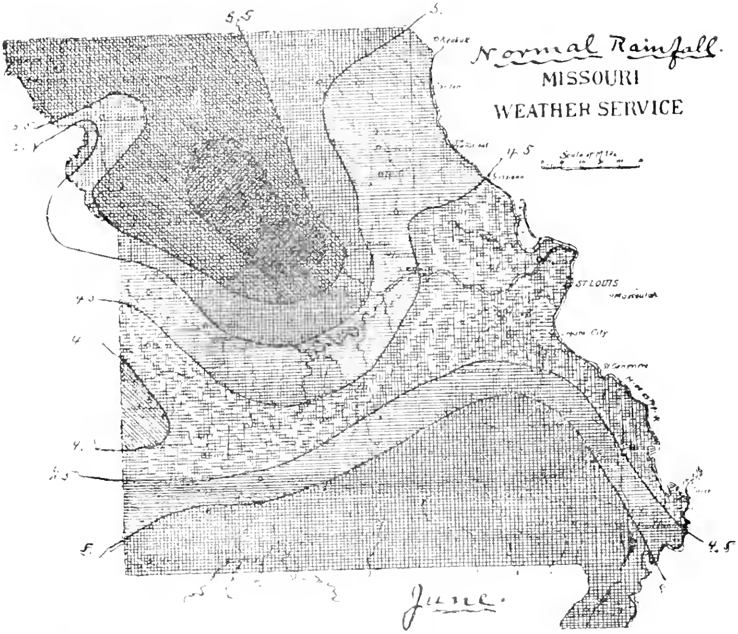

Normal Rainfall
MISSOURI
WEATHER SERVICE
Scale of Miles
5
6
7
8
9
10
11
12
ST. LOUIS
Winter

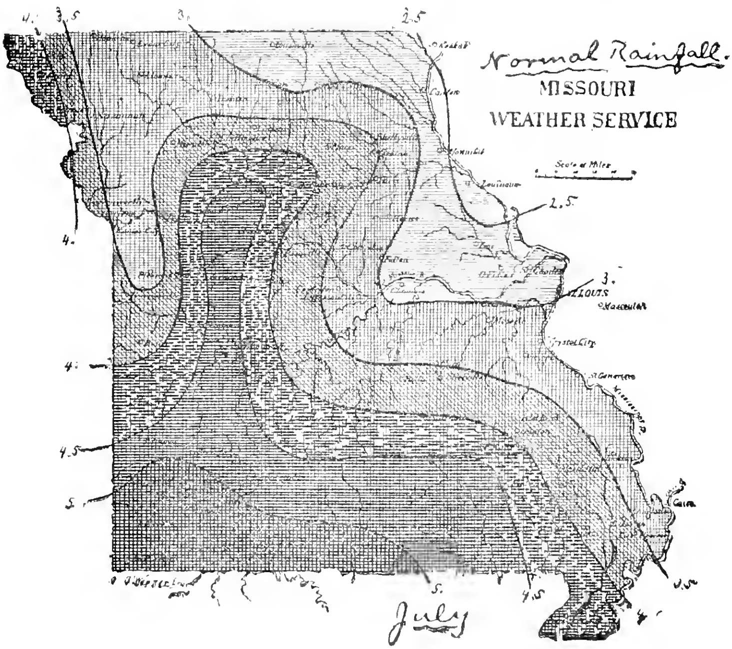

Normal Rainfall
MISSOURI
WEATHER SERVICE
Scale of Miles
1.5
2
2.5
3
ST LOUIS
Crystal City
March

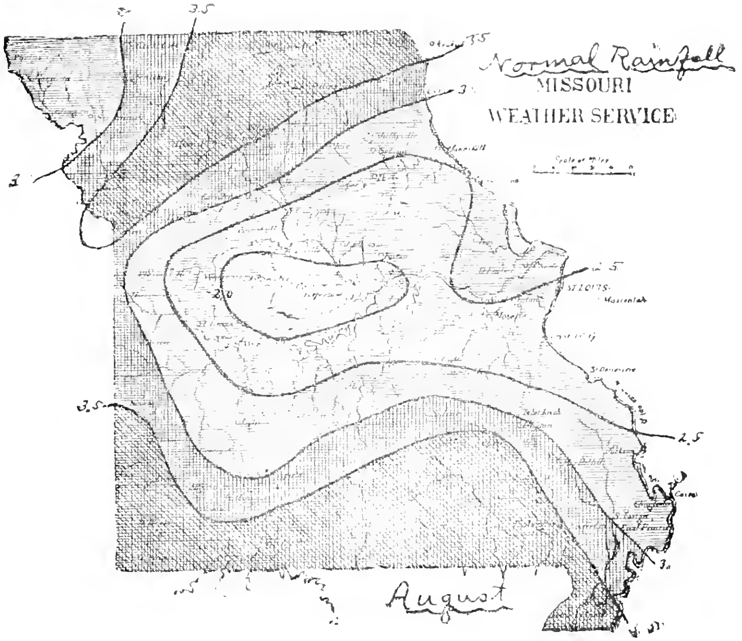

Normal Rainfall
MISSOURI
WEATHER SERVICE
Scale of Miles
3.5
3
2.5
ST LOUIS
Crystal City
April

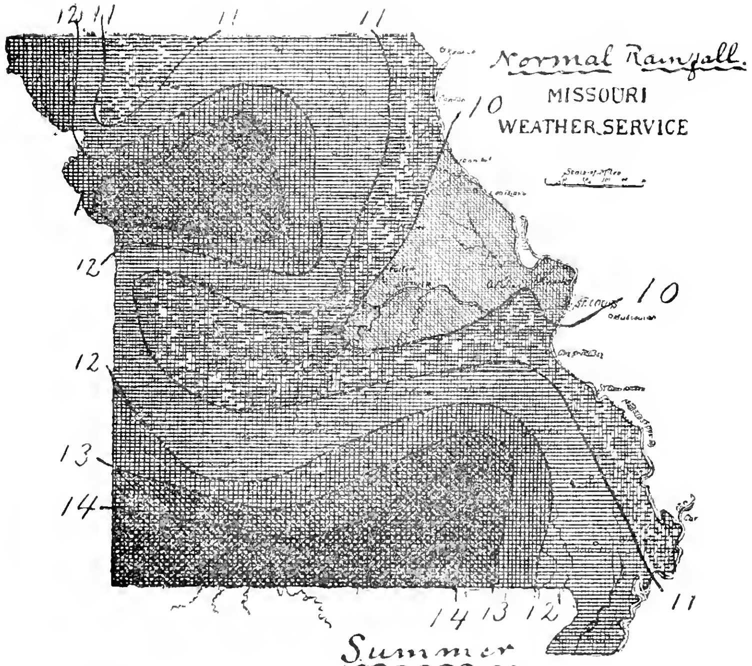

Normal Rainfall
MISSOURI
WEATHER SERVICE
May

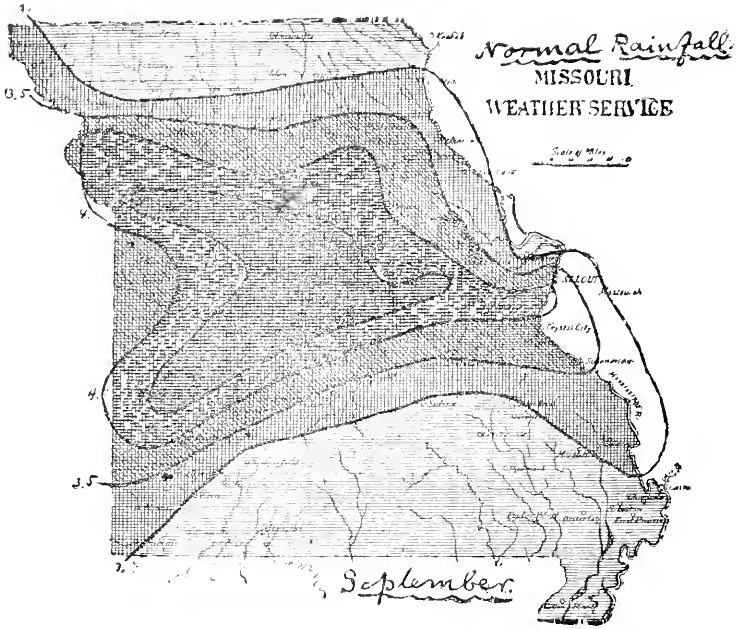

Normal Rainfall.
MISSOURI
WEATHER SERVICE
Spring.

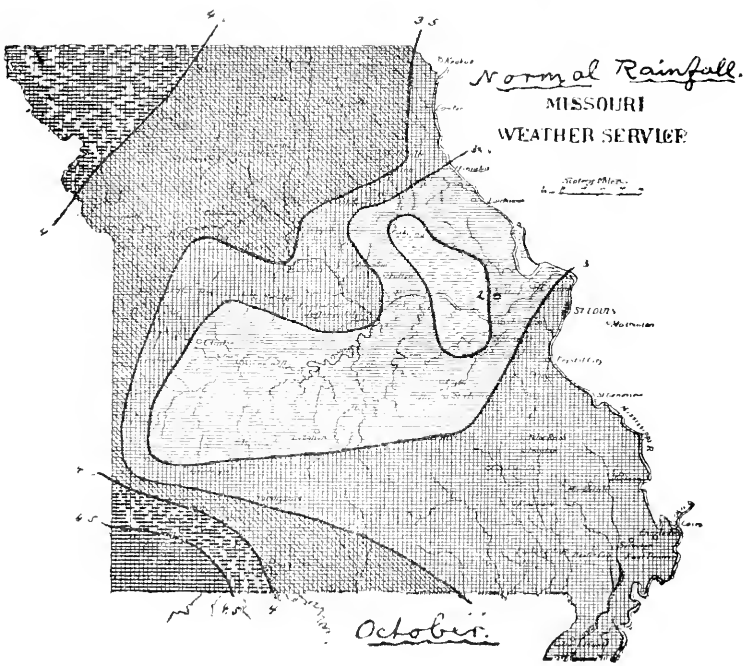

Normal Rainfall.
MISSOURI
WEATHER SERVICE
St Louis
June.

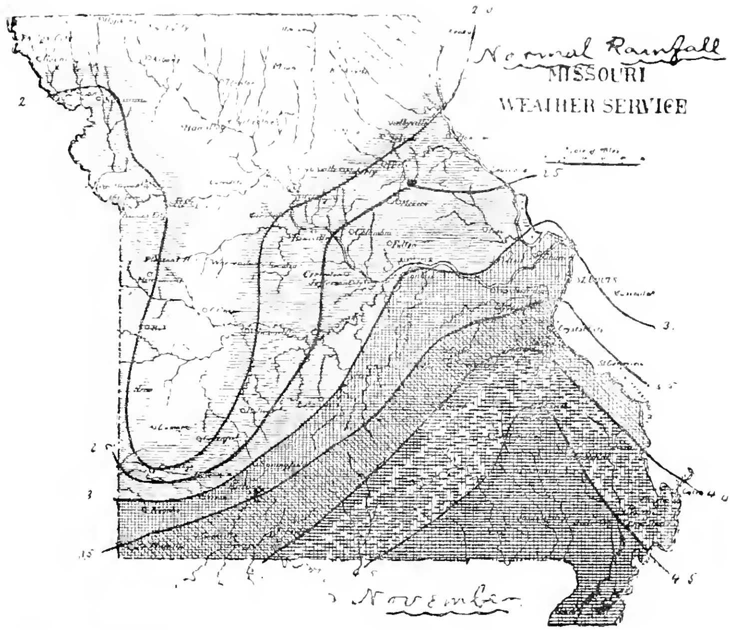

Normal Rainfall.
MISSOURI
WEATHER SERVICE
St Louis
July

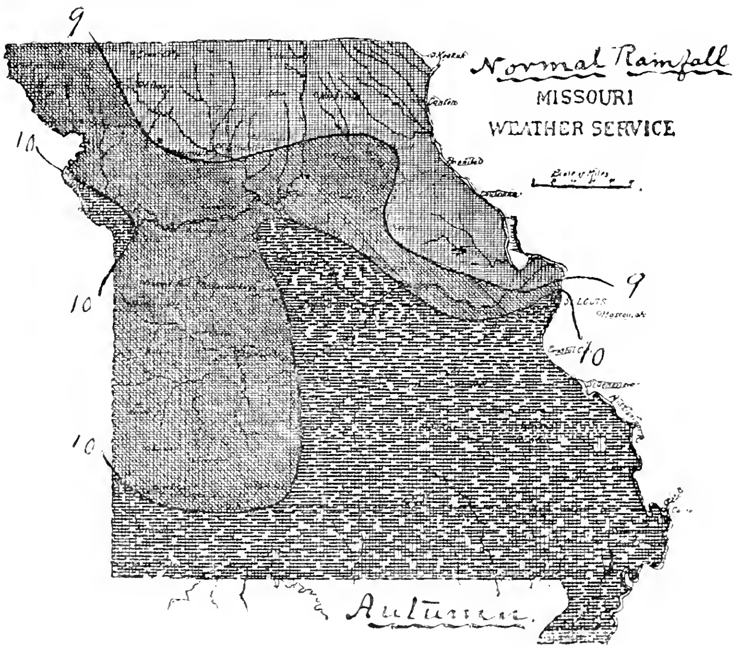

Normal Rainfall
MISSOURI
WEATHER SERVICE
3.5
3
2.5
2.0
ST. LOUIS
August

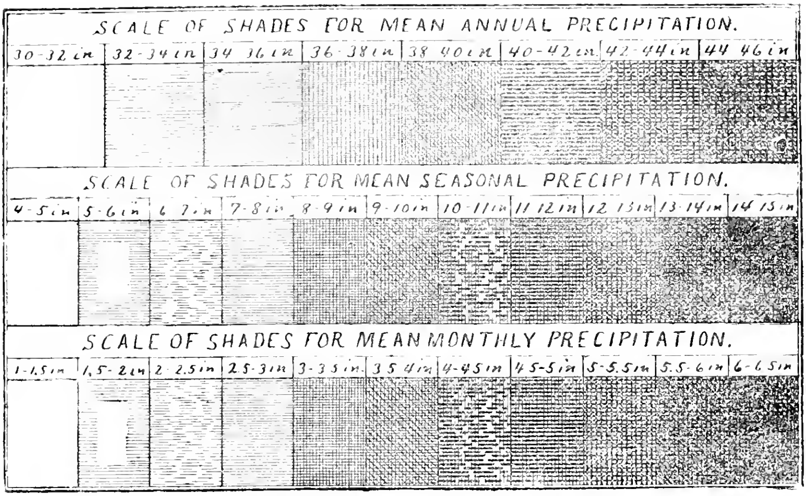

Normal Rainfall.
MISSOURI
WEATHER SERVICE
12
11
10
13
14
ST. LOUIS
Summer

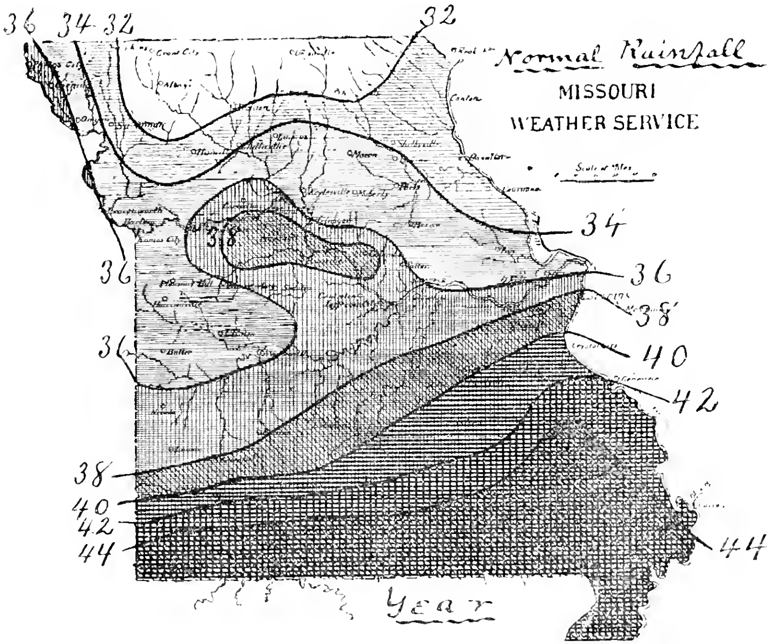

Normal Rainfall.
MISSOURI
WEATHER SERVICE
Scale of Miles
3.5
4.
4.
3.5
St. LOUIS
Crystal City
September.


Normal Rainfall.
MISSOURI
WEATHER SERVICE
Scale of Miles
4.
3.5
3.
2.5
ST. LOUIS
October.


Normal Rainfall
MISSOURI
WEATHER SERVICE
2.5
3.
4.0
4.5
November


Normal Rainfall
MISSOURI
WEATHER SERVICE
9
10
9
10
10
10
Autumn.


SCALE OF SHADES FOR MEAN ANNUAL PRECIPITATION.
30-32 in
32-34 in
34-36 in
36-38 in
38-40 in
40-42 in
42-44 in
44-46 in
SCALE OF SHADES FOR MEAN SEASONAL PRECIPITATION.
4-5 in
5-6 in
6-7 in
7-8 in
8-9 in
9-10 in
10-11 in
11-12 in
12-13 in
13-14 in
14-15 in
SCALE OF SHADES FOR MEAN MONTHLY PRECIPITATION.
1-1.5 in
1.5-2 in
2-2.5 in
2.5-3 in
3-3.5 in
3.5-4 in
4-4.5 in
4.5-5 in
5-5.5 in
5.5-6 in
6-6.5 in


Normal Rainfall
MISSOURI
WEATHER SERVICE
36
34
32
32
34
36
38
40
42
44
38
36
36
38
40
42
44
Year

MISSOURI RAINFALL.

Station.	County.	State	Number.	January. Average.	Max. Amt.	Max. Year.	Min. Amt.	Min. Year	February. Average.	Max. Amt.	Max. Year.	Min. Amt.	Min. Year.	March. Average.	Max. Amt.	Max. Year.	Min. Amt.	Min. Year.
Boonville	Cooper	Mo.	1	1.51	4.00	1886	0.19	1881	3.26	6.04	1882	0.95	1879	2.25	5.11	1878	0.58	1879
Cairo		Ills.	2	3.48	6.35	1882	2.15	1887	4.68	10.14	1882	1.48	1885	2.84	4.52	1880	1.08	1885
Carthage	Jasper	Mo.	3	1.55	2.30	1885,'86	0.70	1887	2.92	5.12	188.	1.15	1885	1.90	3.75	1882	0.87	1883
Centreville	Reynolds	Mo.	4	2.12	3.57	1880	1.00	1881	4.04	6.95	1883	0.85	1885	2.91	6.11	1880	0.92	1879
Chamois	Osage	Mo.	5	1.64	3.03	1886	0.09	1881	3.36	8.98	1882	0.74	1886	2.19	4.34	1884	0.51	1885
Glasgow, Morrison Observatory	Howard	Mo.	6	1.12	2.16	1886	0.00	1881	2.20	4.51	1881	0.12	1879	1.88	4.38	1878	0.00	1885
Glasgow	Howard	Mo.	7	1.35	2.16	1886	0.01	1881	2.60	5.45	1881	0.47	1879	2.02	4.35	1878	0.34	1885
Greenfield	Dade	Mo.	8	1.04	1.70	1881	0.30	1883	2.06	5.55	1882	0.60	1885	1.49	2.70	1882	0.50	1885
Hermann	Gasconade	Mo.	9	1.80	3.15	1886	0.19	1881	3.07	6.66	1882	0.89	1885	2.66	5.24	1878	0.85	1885
Ironton	Iron	Mo.	10	2.58	5.30	1880	1.17	1881	3.88	7.45	1883	0.65	1885	2.86	5.97	1880	0.97	1879
Kansas City	Jackson	Mo.	11	0.92	2.35	1880	0.00	1881	1.90	4.11	1881	0.23	1886	1.71	2.69	1884	0.42	1885
Keokuk	Iowa	Iow.	12	1.42	3.91	1880	0.17	1878	2.53	6.15	1883	0.53	1879	2.07	3.78	1878	0.17	1885
Kirksville	Adair	Mo.	13	1.20	3.77	1880	0.00	1881	2.06	4.72	1881	0.40	1879	1.82	3.57	1881	0.01	1885
Lamar	Barton	Mo.	14	1.31	2.91	1886	0.30	1880	2.69	7.97	1882	*0.70	1885	2.02	3.88	1878	0.75	1879
Leavenworth		Kas.	15	1.28	2.34	1878	0.44	1881	1.87	4.84	1881	0.54	1879	1.62	3.70	1884	0.31	1885
Lexington	Lafayette	Mo.	16	1.48	2.29	1880	0.34	1881	2.26	4.29	1881	0.48	1879	1.59	2.67	1881	0.42	1885
Louisiana	Pike	Mo.	17	1.47	*3.00	1886	0.00	1881	2.92	6.55	1882	0.30	1879	2.16	4.52	1878	0.10	1885
Mascoutah	St. Clair	Ills.	18	1.73	2.87	1882	0.27	1881	3.59	6.54	1882	1.28	1885	2.99	5.03	1887	0.56	1885
Mexico	Audrian	Mo.	19	1.57	2.91	1885	0.26	1881	2.88	6.32	1882	0.63	1879	2.21	4.37	1884	0.38	18·5
Miama	Saline	Mo.	20	1.55	3.05	1886	0.36	1881	2.51	4.52	1881	0.43	1879	1.90	3.89	1878	0.45	1885
Oregon	Holt	Mo.	21	1.56	3.03	1886	0.71	1882	2.00	5.25	1881	0.48	1879	1.50	2.71	1886	0.40	1885
Pierce City	Lawrence	Mo.	22	1.73	2.60	1880	0.90	1884	4.21	7.65	1883	0.90	1885	2.56	4.00	1882	0.60	1879
Pleasant Hill	Cass	Mo.	23	1.23	2.20	1880	0.15	1881	2.29	4.65	1881	0.40	1879	1.67	2.55	1881	0.50	1885
Savannah	Andrew	Mo.	24	1.26	2.12	1886	0.57	1881	1.70	4.22	1881	0.40	1886	1.47	*2.80	1878	*0.40	1879,'85
Sedalia	Pettis	Mo.	25	1.74	4.01	1885	0.19	1881	2.55	4.95	1882	0.65	1879	1.95	3.27	1881	0.43	1879
Shelbina	Shelby	Mo.	26	1.49	2.90	1886	0.03	1881	2.41	4.30	1883	*0.70	1879	2.13	*3.80	1878	0.23	1885
Springfield	Greene	Mo.	27	1.75	2.80	1885	*0.70	1884	3.34	7.29	1882	0.66	1879	2.32	3.27	1878	1.40	1879
St. Charles	St. Charles	Mo.	28	1.69	3.50	1886	0.25	1881	3.65	8.01	1882	0.80	1885	2.50	4.25	1884	0.50	1885
St. Joseph	Buchanan	Mo.	29	1.07	2.18	1878	0.00	1884	1.31	3.33	1883	0.40	1879,'85	1.46	2.33	1878	0.17	1879
St. Louis, Washington University		Mo.	30	2.36	3.94	1880	0.39	1881	3.50	7.21	1882	1.00	1885	2.71	3.87	1887	0.49	1885
" Signal Office		Mo.	31	1.99	3.83	1880	0.49	1881	3.55	8.94	1882	0.87	1885	2.49	3.54	1887	0.40	1885

Station.	Number.	April. Average.	Max. Amt.	Max. Year.	Min. Amt.	Min. Year.	May. Average.	Max. Amt.	Max. Year.	Min. Amt.	Min. Year.	June. Average.	Max Amt.	Max Year.	Min. Amt.	Min. Year.	July. Average.	Max. Amt.	Max. Year.	Min. Amt.	Min. Year.
Boonville	1	3.41	6.26	1882	1.45	1883	5.19	7.92	1878	1.94	1879	6.57	10.84	1879	3.57	1878	3.69	6.83	1884	1.05	1881,'86
Cairo	2	3.90	6.64	1886	1.43	1885	4.05	10.22	1882	1.37	1887	4.23	8.70	1879	1.81	1881	3.25	7.95	1883	0.18	1881
Carthage	3	3.38	7.54	1885	1.47	1883	4.13	6.47	1878	1.12	1886	4.81	7.23	1887	*2.50	1880	5.21	12.18	1883	1.50	1881
Centreville	4	2.95	6.57	1887	1.18	1882	4.11	8.06	1882	1.06	1884	5.37	10.73	1885	2.20	1878	4.64	7.95	1878	0.05	1886
Chamois	5	3.47	*6.30	1878	1.29	1883	4.07	7.33	1882	1.85	1879	4.58	7.94	1885	2.12	1880	2.71	5.93	1885	0.24	1881
Glasgow, Morrison Observatory	6	2.83	6.48	1885	0.99	1880	3.57	5.77	1883	1.57	1879	4.99	8.04	1883	1.06	1880	3.51	12.16	1884	0.40	1886
Glasgow	7	2.64	5.31	1885	1.07	1880	3.53	6.00	1880	1.69	1879,'86	5.50	11.00	1883	0.96	1878	3.81	10.95	1884	0.40	1886
Greenfield	8	3.08	6.50	1884	0.65	1881	4.22	7.00	1878	2.50	1884	4.34	*6.50	1883	1.85	1880	4.62	9.00	1883	1.70	1881
Hermann	9	3.30	6.52	1878	1.02	1883	3.99	5.57	1882	2.14	1879	4.37	7.24	1886	2.01	1887	2.90	8.20	1884	0.00	1883,'86
Ironton	10	3.34	5.90	1878	1.43	1879	5.13	9.55	1882	1.35	1879	5.23	9.15	1885	2.26	1878	3.85	7.00	1884	0.95	1881
Kansas City	11	2.95	6.80	1885	1.26	1886	3.54	6.47	1883	1.70	1879	5.49	10.95	1883	2.26	1878	3.42	6.93	1883	0.00	1886
Keokuk	12	2.52	4.79	1880	1.00	1887	3.78	7.11	1882	1.35	1881	4.90	9.45	1882	1.55	1887	2.39	4.23	1882	0.65	1886
Kirksville	13	2.29	5.13	1882	0.98	1886,'87	3.32	4.95	1886	0.78	1881	4.96	12.61	1882	0.42	1878	2.99	5.95	1882	1.26	1878
Lamar	14	3.41	6.64	1885	0.69	1881	4.46	6.61	1878	2.74	1887	4.00	6.90	1887	1.46	1884	4.46	7.75	1885	1.40	1881
Leavenworth	15	2.65	6.63	1885	0.42	1879	4.53	7.33	1883	3.04	1879	5.57	10.84	1883	1.69	1880	3.96	9.43	1884	0.55	1886
Lexington	16	2.96	5.90	1885	0.78	1883	3.92	6.23	1883	2.24	1887	5.66	10.72	1883	0.65	1880	4.34	7.26	1884	0.31	1886
Louisiana	17	2.55	6.00	1885	1.07	1884	3.52	6.37	1880	0.92	1879	4.63	9.75	1883	1.05	1878	2.06	5.28	1884	0.01	1886
Mascoutah	18	3.12	4.67	1878	1.00	1879	3.88	5.81	1886	1.08	1879	3.91	6.69	1883	1.26	1878	3.84	4.84	1882	0.37	1886
Mexico	19	3.18	5.20	1885	1.83	1881	3.70	6.35	1880	1.64	1879	4.57	6.67	1885	2.06	1887	3.22	6.75	1884	0.03	1886
Miama	20	3.37	7.25	1885	1.52	1880,'83	4.07	6.29	1883	1.95	1887	6.46	11.45	1883	1.07	1880	4.62	14.17	1884	0.20	1886
Oregon	21	3.55	5.80	1882	2.15	1887	4.02	6.14	1881	1.90	1885	5.70	14.94	1883	3.08	1887	4.18	7.18	1878	0.20	1886
Pierce City	22	4.04	6.80	1880,'85	1.80	1881	4.69	6.70	1881	2.20	1886	5.09	7.40	1886	3.40	1882	5.67	9.30	1883	2.00	1881
Pleasant Hill	23	3.42	10.05	1885	*1.50	1881	3.70	6.65	1886	0.91	1884	4.87	8.90	1883	2.35	1880	3.45	7.05	1883	0.00	1886
Savannah	24	3.11	5.90	1882	*2.00	1887	3.75	6.50	1883	1.80	1886	5.04	9.32	1883	2.60	1886	3.25	*6.60	1879	0.30	1886
Sedalia	25	3.21	5.09	1885	1.40	1881	4.27	6.51	1886	0.97	1879	5.76	8.92	1885	2.11	1880	3.98	7.83	1883	0.62	1886
Shelbina	26	2.21	5.00	1882	0.81	1880	3.63	*6.10	1878	*1.20	1879	4.82	8.61	1885	1.43	1887	3.61	7.15	1883	0.01	1886
Springfield	27	3.75	6.04	1878	*2.00	1880	5.71	9.30	1886	2.59	1879	4.58	6.65	1887	2.67	1884	4.68	9.22	1884	1.18	1879
St. Charles	28	3.05	4.60	1885	1.45	1886	3.64	5.90	1881	0.81	1879	4.35	7.90	1885	1.35	1887	2.82	5.40	1880	0.50	1886
St. Joseph	29	2.67	4.11	1882	1.66	1884	3.63	5.29	1883	1.39	1879	4.94	11.09	1879	1.05	1880	3.34	9.55	1879	0.42	1886
St. Louis, Washington University	30	3.86	6.31	1878	2.50	1886	3.82	7.93	1886	0.90	1879	4.14	7.26	1886	2.29	1887	2.76	5.37	1880	0.24	1886
" Signal Office	31	3.78	6.74	1878	2.10	1886	3.90	7.84	1886	0.95	1879	4.30	7.68	1885	2.40	1878	3.01	5.17	1880	0.55	1886

* Approximated.

MISSOURI RAINFALL (Continued).

Station.	County.	State	Number.	August. Average.	August. Max. Amt.	August. Max. Year.	August. Min. Amt.	August. Min. Year.	September. Average.	September. Max. Amt.	September. Max. Year.	September. Min. Amt.	September. Min. Year.	October. Average.	October. Max. Amt.	October. Max. Year.	October. Min. Amt.	October. Min. Year.
Boonville	Cooper	Mo.	1	2.15	4.38	1880	0.05	1879	4.79	10.13	1884	0.25	1883	3.43	8.43	1882	0.74	1879
Cairo		Ills.	2	2.75	7.05	1879	0.11	1881	2.88	5.02	1884	0.34	1883	3.13	6.97	1883	0.38	1887
Carthage	Jasper	Mo.	3	3.43	6.42	1883	0.52	1878	3.21	5.00	1880	0.40	1883	4.11	11.76	1883	0.88	1886
Centreville	Reynolds	Mo.	4	3.74	10.27	1879	0.71	1881	2.73	6.26	1885	0.64	1883	2.77	7.50	1883	0.43	1884
Chamois	Osage	Mo.	5	2.02	5.13	1885	*0.25	1881	4.16	8.93	1881	0.35	1883	2.92	8.70	1883	1.00	1886,'87
Glasgow, Morrison Observatory	Howard	Mo.	6	2.23	6.08	1880	0.37	188[illegible]	4.02	8.38	1884	0.49	1883	3.32	7.58	1883	1.42	1887
Glasgow	Howard	Mo.	7	2.19	6.00	1885	0.23	1879	4.39	8.64	1884	0.39	1883	3.54	7.93	1883	1.50	1880
Greenfield	Dade	Mo.	8	3.02	7.00	1885	0.10	1882	3.47	7.60	1885	0.00	1883	2.91	8.30	1881	1.05	1879
Hermann	Gasconade	Mo.	9	2.60	4.71	1885	0.20	1881	4.60	8.73	1885	1.55	1883	2.15	5.58	1881	0.28	1887
Ironton	Iron	Mo.	10	2.99	8.30	1879	1.20	1884	2.87	4.90	1886	0.75	1883	3.26	8.50	1883	0.70	1887
Kansas City	Jackson	Mo.	11	4.09	12.26	1880	0.49	1879	4.41	8.99	1885	0.82	1883	3.69	7.78	1883	0.75	1878
Keokuk	Ila. or	Iowa..	12	3.59	5.98	1885	0.86	1881	2.82	4.25	1884	1.12	1879	3.36	8.01	1881	0.28	1879
Kirksville	Adair	Mo.	13	3.58	4.54	1884	0.[illegible]8	1881	2.75	5.05	1881	1.12	1883	3.70	11.30	1881	1.38	1879
Lamar	Barton	Mo.	14	3.72	7.20	1880	1.[illegible]7	188[illegible]	4.40	13.24	1885	0.25	1883	3.04	7.83	1883	0.88	1878
Leavenworth		Kas.	15	3.38	7.11	1887	0.1[illegible]	1879	3.98	7.65	1885	0.95	1882	3.93	8.31	1883	1.16	1878
Lexington	Lafayette	Mo.	16	2.96	5.14	1880	0.4[illegible]	1879	4.23	6.84	1884	1.25	1883	3.26	5.42	1883	1.58	1878
Louisiana	Pike	Mo.	17	2.54	5.12	1886	0.06	1881	3.34	8.46	1886	0.19	1883	2.86	8.95	1881	0.41	1887
Mascoutah	St. Clair	Ills.	18	2.28	4.35	1885	0.54	[illegible]881	3.06	7.25	1886	0.03	1883	3.42	7.81	1883	0.76	1876
Mexico	Audrian	Mo.	19	2.42	5.58	1878	0.69	[illegible]881	3.89	8.21	1884	0.31	1883	2.39	5.39	1881	0.73	1877
Miami	Saline	Mo.	20	3.43	6.52	1884	0.59	1[illegible]83	4.34	6.59	1884	*0.80	1883	3.67	6.47	1883	1.63	1878
Oregon	Holt	Mo.	21	2.59	6.61	1880	0.67	1[illegible]2	3.32	4.97	1887	0.74	1882	4.22	6.50	1883	1.85	1887
Pierce City	Lawrence	Mo.	22	3.71	7.20	1885	0.00	18[illegible]2	3.38	7.30	1884	0.20	1883	4.61	9.50	1882	1.40	1885
Pleasant Hill	Cass	Mo.	23	2.55	5.50	1880	0.20	18[illegible]	3.56	10.30	1884	1.31	1879	3.57	8.13	1883	1.27	1878
Savannah	Andrew	Mo.	24	2.57	6.81	1880	0.75	18[illegible]	3.06	5.25	1887	*0.70	1882	4.13	7.75	1881	*2.00	1878
Sedalia	Pettis	Mo.	25	1.67	2.81	1878	0.60	18[illegible]	4.50	10.54	1884	*0.40	1883	3.09	7.07	1883	0.51	1878
Shelbina	Shelby	Mo.	26	2.66	4.70	1884,'86	0.02	1881	3.94	7.50	1886	0.20	1883	3.72	9.90	1883	*0.50	1879
Springfield	Greene	Mo.	27	2.94	4.43	1878	1.50	1879	2.79	6.15	1885	*0.40	1883	3.40	7.62	1882	0.40	1886
St. Charles	St. Charles.	Mo.	28	2.76	5.70	1885	0.60	1881	2.75	5.10	1886	0.00	1883	2.77	6.40	1881	0.70	1886
St. Joseph	Buchanan	Mo.	29	2.96	6.98	1880	0.51	18[illegible]2	2.85	5.41	1886	0.46	1882	4.02	12.24	1881	0.62	1884
St. Louis, Washington University		Mo.	30	2.20	5.06	1878	0.27	1881	3.99	9.57	1886	0.00	1883	3.23	7.60	1881	0.57	1879
" Signal Office		Mo.	31	2.21	4.75	1878	0.31	1881	3.98	9.60	1886	0.01	1883	3.39	7.51	1885	0.68	1879

Station.	Number.	November. Average.	November. Max. Amt.	November. Max. Year.	November. Min. Amt.	November. Min. Year.	December. Average.	December. Max. Amt.	December. Max. Year.	December. Min. Amt.	December. Min. Year.	Average Annual Rainfall.	Maximum Annual Rainfall.	Year.	Minimum Annual Rainfall.	Year.	Spring. March Apl. May.	Summer. June. July. Aug.	Autumn. Sept. Oct. Nov.	Winter. Dec. Jan. Feb.
Boonville	1	2.40	5.98	1881	0.63	1878	1.90	3.00	1887	0.78	1886	40.55	54.85	1882	28.56	1879	10.85	12.41	10.62	6.67
Cairo	2	4.06	5.96	1882	2.41	1884	3.88	8.99	1884	1.74	1886	43.13	61.58	1882	26.75	1887	10.79	10.23	10.07	12.04
Carthage	3	2.03	4.36	1881	0.84	1885	2.25	6.91	1884	0.89	1882	38.93	53.67	1883	28.71	1879	9.41	13.45	9.35	6.72
Centreville	4	4.28	6.82	1879	1.30	1884	3.00	7.22	1884	1.82	1883	42.66	55.02	1883	34.43	1887	9.97	13.75	9.78	9.16
Chamois	5	2.97	8.34	1881	0.60	1885	2.24	4.37	1884	0.75	1886	36.33	43.52	1882	21.08	1880	9.73	9.31	10.05	7.24
Glasgow, Morrison Observatory	6	1.51	3.96	1882	0.46	1878	1.90	4.20	1878	0.41	1886	33.06	47.96	1884	23.65	1879	8.28	10.73	8.85	5.22
Glasgow	7	1.89	4.13	1882	0.50	1878	1.97	3.82	1878	0.40	1886	35.43	48.50	1884	26.09	1879	8.19	11.50	9.82	5.92
Greenfield	8	1.70	3.40	1881	0.60	1885	1.80	3.80	1884	0.97	1882	33.75	42.60	1885	26.10	1879	8.79	11.98	8.08	4.90
Hermann	9	2.97	5.36	1879	1.46	1878	2.16	3.52	1883	1.15	1886	36.58	46.78	1884	27.61	1883	9.95	9.87	9.72	7.03
Ironton	10	4.67	8.72	1879	1.69	1878	3.33	7.47	1884	1.92	1883	43.99	56.64	1883	33.31	1887	11.33	12.07	10.80	9.79
Kansas City	11	2.19	4.97	1879	0.51	1878	1.42	3.34	1878	0.00	1880	35.73	49.52	1885	19.04	1886	8.20	13.00	10.29	4.24
Keokuk	12	1.88	3.91	1879	0.88	1885	1.83	3.91	1884	0.67	1880	33.09	41.24	1882	22.51	1879	8.37	10.88	8.06	5.78
Kirksville	13	1.68	3.65	1879	0.25	1885	1.39	2.53	1884	0.22	1886	31.73	45.43	1882	22.20	1886	7.43	11.53	8.13	4.65
Lamar	14	1.93	4.45	1879	0.49	1885	2.09	*5.00	1884	0.82	1886	37.53	48.75	1885	33.48	1886	9.89	12.18	9.37	6.09
Leavenworth	15	2.48	7.85	1879	1.10	1886	1.35	2.55	1887	0.40	1880	36.60	44.72	1884	22.25	1886	8.80	12.91	10.39	4.50
Lexington	16	2.01	4.10	1882	0.50	1878	2.06	4.00	1878	0.51	1886	36.74	45.50	1885	23.73	1886	8.47	12.96	9.50	5.80
Louisiana	17	2.20	3.95	1881	1.30	1884	2.13	3.62	1887	0.61	1883	32.37	41.02	1882	21.50	1879	8.23	9.23	8.40	6.52
Mascoutah	18	2.84	6.65	1881	0.71	1878	2.99	5.58	1884	1.55	1881	37.65	43.09	1883	31.48	1879	9.99	10.03	9.32	8.31
Mexico	19	2.68	5.83	1879	1.26	1878	2.48	4.02	1887	0.88	1886	35.19	46.09	1882	27.04	1887	9.09	10.21	8.96	6.93
Miami	20	1.97	*3.00	1882	0.54	1878	2.23	3.68	1884	0.70	1886	40.12	55.68	1884	31.13	1880	9.34	14.51	9.98	6.29
Oregon	21	2.02	7.81	1879	0.48	1885	1.37	2.19	1878	0.81	1886	36.03	46.91	1883	29.57	1885	9.07	12.47	9.55	4.93
Pierce City	22	3.19	6.00	1879	1.30	1878	2.82	10.10	1884	1.00	1882,'85	45.70	51.95	1883	36.60	1879	11.29	14.47	11.18	8.76
Pleasant Hill	23	2.05	*4.30	1879	0.62	1878	1.88	3.98	1878	0.40	1880	34.24	48.10	1883	23.95	1886	8.79	10.87	9.18	5.40
Savannah	24	2.10	8.90	1879	0.70	1878	1.36	2.20	1884	0.45	1886	32.79	41.21	1881	22.16	1886	8.33	10.86	9.29	4.32
Sedalia	25	1.96	3.17	1881	0.53	1885	2.00	4.77	1884	0.53	1886	36.68	49.84	1884	23.28	1880	9.43	11.41	9.55	6.29
Shelbina	26	1.87	3.60	1879	0.18	1884	1.81	4.20	1884	0.76	1880	34.30	43.98	1883	24.75	1879	7.97	11.09	9.53	5.71
Springfield	27	2.99	6.30	1882	0.52	1878	2.59	7.62	1884	0.75	1886	40.84	55.43	1882	25.06	1879	11.78	12.20	9.18	7.68
St. Charles	28	3.32	6.60	1881	1.10	1878	2.10	3.70	1884	0.80	1881	35.40	44.30	1884	29.11	1878	9.19	9.97	8.84	7.44
St. Joseph	29	2.13	8.45	1879	0.76	1886	1.00	1.92	1878,'79	0.46	1885	31.39	44.21	1879	22.61	1884	7.76	11.24	9.09	3.38
St. Louis, Washington University	30	3.28	6.32	1881	1.02	1878	2.76	6.63	1884	1.42	1883	38.60	46.40	1886	25.96	1879	10.39	9.10	10.50	8.61
" Signal Office	31	3.40	6.74	1881	1.38	1878	2.75	6.18	1884	1.40	1881	38.76	45.59	1885	25.70	1879	10.17	9.52	10.77	8.29

* Approximated.

Report on Missouri Rainfall, with Averages for Ten Years ending December, 1887.

By Francis E. Nipher.

In the autumn of 1877 the writer secured the coöperation of observers in various parts of Missouri, with a view of making observations on rainfall and temperature. The volunteer organization then formed, and which began operations in December of that year, was known as the "Missouri Weather Service." The observers were nearly all furnished with rain-gauges similar to those already in use in the Iowa Weather Service, and for which they paid the cost price. These gauges were plain cylinders of heavy tin plate, having a depth of one foot and a diameter of 7.06 centimeters, so that each cubic centimeter of water caught represented a hundredth of an inch of rainfall. The rainfall was, however, in most, if not all, cases determined by observing the wetted part of a small box-wood scale, graduated to inches and tenths.

The rain-gauge was the only instrument furnished to observers by the central office. In a few cases, observers bought Green's thermometers, and others observed temperatures with ordinary thermometers. The labor involved in the direction of a complete meteorological service was, however, greater than the director could undertake, and it has unfortunately happened that the supervision needed in order to obtain first-class rainfall data could not be given. It was hoped that Missouri would follow the example of Iowa, and establish the weather service as a state institution, and to that end a bill was introduced into the Legislature in 1882 to establish such a weather service, granting a couple of thousand dollars per annum for its support. The consideration of this bill furnished an occasion for mirth to some of the members of that body, but failed to awaken any general interest.

This experience was, in fact, so depressing that no further attempt has been made in that direction.* Twenty-five other states

* Since the above was written a bill has been introduced into the Legislature by Mr. Tuttle, of Pettis county. There is little reason to believe that it will pass, although mem-

now have weather services, and the number receiving state support is increasing in a very gratifying way. The function of the state weather service is as clearly distinct from that of the national weather service as that of the state government is from the national. The state weather service should study the climate of the state, giving particular attention to the distribution of rainfall and temperature. It should also make a complete study of local summer storms — which are of such supreme importance to the farmer. When the telephone shall have become public property, so that county telephone services can be organized to serve farmers at lower rates, it will be possible to combine such service with local storm warnings which will save millions of dollars to the farmers of the state. In the mean time the local peculiarities of these storms should receive a thorough investigation in each state where the people understand their own interests sufficiently to establish a weather service, and a state weather service is the only feasible way to study them. The national weather service should give warning of cold waves and the larger storms, occurring mainly in winter, the movements of which are revealed by the barometer. These predictions are of great value to shipping on the lakes and the Atlantic coast, and to dealers in perishable goods. In this direction lies the great value of the national weather service, and the state services could give efficient aid in distributing such predictions. But the national weather service will never be able to deal with summer thunder-storms, which usually cover only a few counties. It will be the work of state weather services to establish systems of "harvest warnings," and in the near future this will be done.

The present paper gives the results of ten years of rainfall observation by the observers of the Missouri Weather Service. This work has required much patience and self-denial on the part of the observers, and they are entitled to the thanks of the people of the state.

Before proceeding to a description of the stations of observation, it should be stated that the observations made by those reporting regularly to this office have all been reduced anew from

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bers of the appropriation committee were disposed to recommend it if the Director would consent to serve without salary. As a rule, statesmen who make such propositions do not take their own medicine.

the daily observations, on file at the Washington university. This work, as also the working out of all the average values, has been done by Serg't G. A. Weber, of the Signal Service, now acting as assistant in this office. In the following list of stations, those reporting to this office are indicated by the initials M. W. S. following the name of the station or observer. In case of M. W. S. observers, where the gauge is not described, it will be understood that the Iowa gauge was used. Other data has been republished from Mr. Schott's paper in the "Smithsonian Contributions to Knowledge," vol. xxiv. Such stations are indicated by an S. following the name of the station or observer. The latitudes and longitudes are only approximate. The word "*grade*" preceding the word "elevation" means that the altitude given is that of the railroad track at that point.

Allenton, St. Louis Co., Mo. S. Lat. 38° 39′; Lon. 90° 45′: elevation 482 ft. A. Fendler obs.

Ashley, Pike Co., Mo. S. Lat. 39° 20′; Lon. 91° 12′: elevation about 850 ft. Jno. C. Watkins obs.

On Big Creek, Lincoln Co., Mo. Lat. 38° 57′; Lon. 90° 59′. F. L. Jabin obs. M. W. S., Jan. 1878 to Apr. 1882. E. J. W. Pollien obs. M. W. S. after Apr. 1882 to Jul. 1883.—Mr. Jabin's gauge was about 56 rods s.w. of the n.e. corner of sec. 28, tp. 48, r. 1 w. of the 5th principal meridian. The top of the gauge was 24 in. above the ground. The nearest objects were, a clump of cedars 14 feet high, 25 ft. e.; smoke-house 16 ft. high, 75 ft. s.; hen-house 12 ft. high, 50 ft. n. The latter stood about 4 ft. below the level of the top of the rain-gauge.

Bolivar, Polk Co., Mo. Lat. 37° 35′; Lon. 93° 30′: elevation 1,000 ft. J. A. Race obs. S., Dec. 1868 to Dec. 1869. J. W. Farmer obs. M. W. S., Jan. 1878 to Mar. 1884.

Booneville, Cooper Co., Mo. Lat. 38° 54′; Lon. 92° 46′: grade elevation about 700 ft. Chas. W. Hazell, Signal Service river observer, Aug. 1875 to Dec. 1887. The signal service standard gauge was used. T. A. Johnson, of Kemper School, obs. M. W. S., Jun. 1878 to Feb. 1881. W. M. Hoge, of the same school, M. W. S. obs., Mar. 1881 to Dec. '84.

Brunswick, Chariton Co., Mo. Lat. 39° 27′; Lon. 93° 14′: grade elevation 655 ft. G. W. Kennedy, S. S. river obs., Jul. 1874 to Apr. 1883, with S. S. standard gauge.

Carrollton, Carroll Co., Mo. Lat. 39° 22′; Lon. 94° 22′: grade elevation 680 ft. J. B. Conkling, M. W. S. obs., Aug. 1879 to Mar. 1881.

Carthage, Jasper Co., Mo. Lat. 37° 36′; Lon. 94° 22′: M. Wilson obs. M. W. S., Jan. 1878 to May 1880. D. Matthews obs. M. W. S., July 1880 to Feb. 1885. D. R. Goucher. M. W. S. obs. Mar. 1885 to Dec. '87.

Cave Springs, Greene Co., Mo. Lat. 37° 20'; Lon. 93° 30': elevation 1300 ft. R. H. McCon and M. Cochrane obs. S., Jan. 1871 to Mar. '75.

Centreville, Reynolds Co., Mo. Lat. 37° 25'; Lon. 90° 58': elevation — ft. M. McKenzie obs. M. W. S., Apr. 1878 to May 1887.

Chamois, Osage Co., Mo. Lat. 38° 39'; Lon. 91° 45': elevation grade 525 ft. G. W. Dallas obs. M. W. S., Jan. 1879 to Dec. 1886.—Gauge exposed in the midst of a garden 40×39 ft without any object inside the enclosure. Two walnut-trees about 25 ft. e. and s.e. having height of about 25 ft; about 10 ft. e. of these trees was a two-story building; no other high objects near. Top of gauge 18 in. above ground.

Chillicothe, Livingston Co., Mo. Lat. 39° 48'; Lon. 93° 37': grade elevation 775 ft. Dr. A. S. Cloud obs. M. W. S., Jan. 1878 to Aug. 1878; W. B. Costin, May 1880 to Dec. 1881. Eugene Daly obs. M. W. S., Jan. 1882 to Jun. 1882.

Clinton, Henry Co., Mo. Lat. 38° 22'; Lon. 93° 48': grade elevation 1,000 ft. J. W. Keil obs. M. W. S., Jan. 1878 to Aug. 1878. T. M. Roberts obs. M. W. S., Nov. 1879 to Aug. 1881. H. F. Dodge obs. M. W. S., Nov. 1881 to Feb. 1883.

Conception, Nodaway Co., Mo. Lat. 40° 22'; Lon. 94° 44': grade elevation 975 ft. Rev. F. M. Eckstein obs. S., Nov. 1883 to Dec. 1887.

Corning, Holt Co., Mo. Lat. 40° 17'; Lon. 95° 31': grade elevation 900 ft. Horace Martin obs. M. W. S., Apr. 1870 to Sept. 1883.

Cuba, Crawford Co., Mo. Lat. 38° 03'; Lon. 91° 22: grade elevation 925 ft. E. A. Pinnell obs. M. W. S., Jun. 1878 to Aug. 1881.

Curryville, Pike Co., Mo. Lat. 39° 0'; Lon. 92° 25°: elevation — ft. W. W. Vermillion, obs. S., Feb. 1882 to Apr. 1884.

East Prairie, Missisisppi Co., Mo. Lat. 36° 50'; Lon. 89° 20'. A. Miller obs., Jan. 1868 to Dec. 1870 S., and Jan. 1878 to Nov. 1879 M. W. S.

Edina, Knox Co., Mo. Lat. 40° 10'; Lon. 92° 12'. J. C. Agnew obs. S., May 1859 to Dec. 1866.

Fayette, Howard Co., Mo. Lat. 39° 16'; Lon. 92° 45': elevation 700 ft. T. B. Smith obs. M. W. S., Feb. 1886 to Dec. 1887. S. S. standard gauge. A sycamore 40 ft. high stands 36 ft. s.e.; a maple 20 ft. high stands 35 ft. n.w.; a building 20 ft. high is 30 ft. e.; a closet 8 ft. high is 16 ft. s.; two or three small fruit-trees about 10 to 20 ft. distant. The rain is measured by a graduated stick.

Forsythe, Taney Co., Mo. Lat. 36° 43'; Lon. 93° 05'. J. J. Brown obs. M. W. S., Oct. 1878 to Aug. 1882.

Gayoso, Pemiscot Co., Mo. Lat. 36° 15'; Lon. 89° 40'. H. Tresenriter obs. M. W. S., Jan. 1878 to July 1881.

Glasgow, Howard Co., Mo. Lat. 39° 13'; Lon. 92° 52': grade elevation 550 ft. M. B. Collins obs. M. W. S., Jan. 1878 to Feb. 1883. T. B. Smith obs. M. W. S., Mar. 1883 to May 1886. C. W. Pritchett, Director of Morrison Observatory, Jan. 1878, to Dec. 1887. The observatory gauge was made by James Green, N. Y., and "has a perfectly circular opening of exactly 20 square inches, and is fitted with lock and key into a copper case firmly attached to a base. Several evergreens have gradually grown up at the distance of 10 to 20 ft. from the gauge; some of these are now 20 ft. high; they enclose the gauge at the centre of a circle. The gauge will be removed: it is 6 ft. above the ground.

Grant City, Worth Co., Mo. Lat. 40° 29': Lon. 94° 27. J. H. Houser obs. M. W. S., Jan. 1878 to April 1881.

Greenfield, Dade Co., Mo. Lat. 37° 24'; Lon. 93° 50'. S. B. Bowles obs. M. W. S., Jan. 1878 to Dec. 1886.

Hamilton, Caldwell Co., Mo. Lat. 39° 46'; Lon. 94° 02°: grade elevation 1,000 ft. M. C. Martin obs. M. W. S., June 1878 to Oct. 1879. Lilla Martin obs. M. W. S., Nov. 1879 to Dec. 1880.

Hannibal, Marion Co., Mo. Lat. 39° 43': Lon. 91° 23': grade elevation 480 ft. O. H. P. Lear obs. S., Jan. 1854 to May 1855. F. W. Gill obs. M. W. S., Sept. 1878 to Apr. 1886.

Harlem, Clay Co., Mo. Lat. 39° 07'; Lon. 94° 38': grade elevation 670 ft. J. C. Evans obs. M. W. S., Jan. 1878 to Mar. 1879.

Harrisonville, Cass Co., Mo. Lat. 38° 30'; Lon. 94° 25'. J. Christian obs. S., Oct. 1863 to Sept. 1870. G. W. Houston, obs. M. W. S., June 1878 to Mar. 1885. A. J. Sharp obs. M. W. S., Aug. 1887 to Dec. 1887. Mr. Sharp's gauge is made of galvanized iron and has a diameter of 8 inches. A dip scale graduated to hundredths of an inch is used in measuring the rainfall. The gauge is on the ground, the top being 14 inches above: it is placed 30 feet n. of a house 14 ft. high.

Hematite, Jefferson Co., Mo. Lat. 38° 11'; Lon. 90° 37': elevation 475 ft. J. M. Smith obs. S., Apr. 1868 to Mar. 1872.

Hermann, Gasconade Co., Mo. Lat. 38° 41', Lon. 91° 23': grade elevation 495 ft. Charles Maushund obs. Sig. Service, Feb. 1874 to Dec. 1887. Signal service standard gauge with top 5 ft. above ground.

Hermitage, Hickory Co., Mo. Lat. 37° 56'; Lon. 93° 15'. J. Moore and Dr. W. Moore obs. S., Sept. 1867 to Dec. 1869.

Hopkins, Nodaway Co., Mo. Lat. 40° 33'; Lon. 94° 51': grade elevation 1065 ft. John Donlin obs. M. W. S.

Houstonia, Pettis Co., Mo. Lat. 38° 53'; Lon. 93° 24'.

Ironton, Iron Co., Mo. Lat. 37° 35'; Lon. 90° 38': grade elevation 935 ft. J. W. Wilkinson obs. M. W. S., Jan. 1878 to July 1879. W. H. Delano obs. M. W. S., Aug. 1879 to Dec. 1887. The gauge is placed 40 ft. from any surrounding object, the highest being trees 30 ft. high.

Jackson, Cape Girardeau Co., Mo. Lat. 37° 20'; Lon. 89° 46'. J. W. Cannon obs. M. W. S., Jan. 1878 to Jan. 1879.

Jefferson Barracks, St. Louis Co., Mo. Lat. 38° 28'; Lon. 90° 15': elevation 472 ft. Assis't Surg. U. S. A. obs., July 1840 to July 1862. C. E. Goddard, Surgeon U. S. A., obs., Jan. 1882 to June 1884.

Jefferson City, Cole Co., Mo. Lat. 38° 35′; Lon. 92° 11′: grade elevation 550 ft. L. C. Lohman obs. S., Apr. 1875 to Nov. 1876; May 1879 to Feb. 1885.

Kansas City, Jackson Co., Mo. Lat. 39° 07′; Lon. 94° 37′: grade elevation 775 ft. J. P. Kenmuir obs. M. W. S., Jan. 1878 to Dec. 1887. G. R. and S. W. Salisbury obs. S., Mar. 1870 to Dec. 1874. H. P. Childs obs. S., Jan. 1875 to Dec. 1877.

Kirksville, Adair Co., Mo. Lat. 40° 10′; Lon. 92° 39′: grade elevation 1000 ft. Prof. B. S. Potter obs. M. W. S. Jan. to June 1878. J. T. Reesman obs. M. W. S., July 1878 to Nov. 1881. Chs. Patterson obs. M. W. S., Apr. 1882 to Dec. 1887. Mr. Patterson's gauge is about 10 ft. above ground, and about 25 ft. w. of a building 30 ft. high. Maple-trees 25 feet high are 30 ft. n. of gauge, and evergreens 15 feet high are 25 to 30 feet n.e.

Lamar, Barton Co., Mo. Lat. 37° 32′; Lon. 94° 15′. Dr. J. W. Dunn obs., Jan. 1878 to June 1884. U. S. Signal Service obs., Mar. 1885 to Dec. 1887.

Lamonte, Pettis Co., Mo. Lat. 38° 46′: Lon. 93° 22′: grade elevation 877 ft. R. A. S. Wade obs. M. W. S., Mar. 1885 to May 1887.

Lebanon, Laclede Co., Mo. Lat. 37° 41′; Lon. 92° 41: grade elevation 1262 ft. J. H. Wolf obs. M. W. S., Jan. 1878 to Jan. 1879. W. J. Diffenderfer obs. M. W. S., Feb. 1879 to Feb. 1880.

Lexington, Lafayette Co., Mo. Lat. 39° 11′; Lon. 93° 56′: elevation —— ft. Dr. J. B. Alexander obs. M. W. S., Jan. 1878 to Sept. 1887. The gauge is on the roof of a building about 30 ft. above ground; it is above all surrounding objects.

Louisiana, Pike Co., Mo. Lat. 39° 27′; Lon. 91° 05′. J. D. Dawson obs. M. W. S., Jan. 1878 to July 1885. M. J. Hassler obs. M. W. S., Feb. 1886 to Dec. 1887. Mr. Dawson's station was on his farm some 2 miles from town. The exposure of his gauge was satisfactory, although no record of it is now at hand. Mr. Hassler's gauge is the Signal Service standard: the top is about 4 ft. above ground. A building 15 ft. high stands 25 ft. n.w., and a tree 12 ft. high stands 15 ft. w. of the gauge.

Macon City, Macon Co., Mo. Lat. 39° 44′; Lon. 92° 31′: grade elevation 880 ft. J. T. Ridgeway obs. M. W. S., Jan. 1878 to June 1884.

Mexico, Audrain Co., Mo. Lat. 39° 10′; Lon. 91° 53′: grade elevation 812 ft. J. F. Llewellyn obs. M. W. S., Jan. 1878 to Dec. 1887. The gauge consists of a cylindrical collector $2\frac{25}{32}$ inches in diameter, terminating below in a funnel which passes into the neck of a bottle. The rainfall is measured by means of a graduated cylinder, one cubic centimeter representing an hundredth of an inch. The top of the gauge is 2 ft. above ground. One building 25 ft. high is 30 ft. e., and another 8 ft. high is 25 ft. s. of the gauge.

Miami, Saline Co., Mo. Lat. 39° 19'; Lon. 93° 17'. Dr. A. H. W. Sullivan obs. M. W. S., Jan. 1878 to Dec. 1887. The top of the gauge is 20 inches above the ground; there is no object in the vicinity of the gauge.

Mound City, Holt Co., Mo. Lat. 40° 09'; Lon. 95° 17'. Lawrence Kaucher obs. M. W. S., May 1886 to Nov. 1887.

Mine La Motte, Madison Co., Mo. Lat. ——; Lon. ——. J. D. Sanders obs. The gauge is a plain cylinder 8 in. in diameter and 12¼ in. high; it is mounted on a post, the top of the gauge being 4 ft. 5½ in. above the ground. The nearest object is a slender pear-tree 18 ft. high and 9½ ft. n. of gauge. The nearest building is 150 ft. s.w. of gauge. A small tree stands 30 feet. s.w.; these trees have grown up since 1885. The rain was measured with a 2-foot rule to the nearest 16th of an inch.

Mount Vernon, Lawrence Co., Mo. Lat. 37° 04'; Lon. 93° 55': elevation 1,420 ft. W. Howis obs. S., July 1871 to July 1874.

Neosho, Newton Co., Mo. Lat. 36° 52'; Lon. 94° 22': grade elevation 1,020 ft. J. M. Sherwood obs. M. W. S., Jan. 1878 to Oct. 1881.

O'Fallon, St. Charles Co., Mo. Lat. 38° 47'; Lon. 90° 35': grade elevation 605 ft. Dr. W. C. Williams obs. M. W. S., June 1881 to Dec. '85. Gauge exposed in a garden, with no obstacles near.

Oregon, Holt Co., Mo. Lat. 39° 59; Lon. 95° 09': elevation 1,100 feet. William Kaucher obs. M. W. S., July 1855 to Dec. 1887. From 1855 to Mar. 1, 1867, the rainfall was approximately measured by means of buckets or other vessels, allowance being made for varying diameter. Since that time a gauge made by James Green, N. Y., has been in use. These periods have been separately reduced. The gauge is — inches in diameter and 10 inches high. It contains a false bottom 5 inches from the top, which is perforated at the centre to allow water to pass through into the lower compartment. The perforation is covered by a cap of zinc, which has openings to allow the water to pass through. The object of this arrangement is to prevent evaporation. Immediately below the false bottom is a tubulure (closed by a cork) through which the water can be discharged into a graduated cylinder which is used to measure the rainfall. The gauge is 6 ft. 4 inches above ground. It is 30 ft. east of a building 15 to 20 ft. high. A few trees are in the vicinity of the gauge, but not near enough to influence the rainfall in the gauge.

Phelps City, Atchison Co., Mo. Lat. 40° 23; Lon. 95° 40': grade elevation 915 ft. J. S. Wade obs. M. W. S., Mar. 1878 to July 1885.

Pierce City, Lawrence Co., Mo. Lat. 37° 07'; Lon. 93° 50': grade elevation 1205 ft. J. J. Spilman obs. M. W. S., July 1878 to Dec. 1887.

Pleasant Hill, Cass Co., Mo. Lat. 38° 46'; Lon. 94° 20': grade elevation 855 ft. G. C. Broadhead obs. M. W. S., Jan. 1878 to Aug. 1887.

Near Protem, Taney Co., Mo. The station is in Arkansas, in tp. 21, r. 17 west of the 5th principal meridian. Silas Turnbo obs. M. W. S., Sept. 1881 to Dec. 1887.

Richland, Pulaski Co., Mo Lat. 37° 51'; Lon. 92° 24': elevation 1,134 ft. S. L. Goodwin obs. S., June 1872 to June 1874.

Rolla, Phelps Co., Mo. Lat. 37° 56'; Lon. 91° 32: elevation 1,150 feet. Station 3½ miles west of the city. H. Ruggles obs. S., April 1866 to June 1876.

Salem, Dent Co., Mo. Lat. 37° 38'; Lon. 91' 31': grade elevation 1,070 ft. W. H. Lynch obs. M. W. S., Mar. 1880 to May 1882.

Savannah, Andrew Co., Mo. Lat. 39° 57'; Lon. 94° 49': grade elevation 1,145 ft. R. Van Buskirk obs. M. W. S., Nov. 1879 to Dec. 1887. The gauge is on a post 4 feet high. A building 75 ft. s., a tree 20 ft. high 45 ft. w., are the nearest objects.

Sedalia, Pettis Co., Mo. Lat. 38° 42'; Lon. 93° 16': grade elevation 895 ft. C. L. Mitchell obs. M. W. S., Jan. to May 1878: C. G. Taylor obs. M. W. S., May 1878 to Dec. 1887. The top of the gauge is 18 in. above ground. The nearest objects are a wood-shed 8 ft. high 16 ft. east, a building 24 ft. n., and a tree 27 ft. n.w. of the gauge.

Shelbina, Shelby Co., Mo. Lat. 39° 41'; Lon. 92° 03': grade elevation 795 feet. J. S. Chandler obs. M. W. S., Nov. 1879 to Dec. 1887. The top of the gauge is 12 ft. above ground. The nearest objects are a tree 15 ft. high 20 ft. w., a barn 20 ft. high 18 ft. s.s.w., and a house 15 ft. high 30 ft. n.w. of the gauge.

Springfield, Greene Co., Mo. Lat. 37° 12'; Lon. 93° 18': grade elevation 1245 ft. A. Milton Lapham obs. M. W. S., Feb. 1877 to Dec. 1877; O. H. Barker obs. M. W. S., Jan. 1878 to Dec. 1880; U. S. Signal Service obs., Jan. 1882 to May 1883; Prof. E. M. Shepard, M. W. S., obs., May 1884 to June 1887: E. F. Coff. M. W. S. obs., July and Aug. 1887: U. S. Signal Service obs., Oct. Nov. and Dec. 1887. The top of Mr. Shepard's gauge is 18 in. above ground. The nearest objects are a tree 15 ft. high 30 ft. s.w., and one 25 ft. high 40 feet n.w. Mr. Coff has a U. S. Signal Service standard gauge; the top of the gauge is 15 ft. 7 in. above ground, the gauge being on the roof of a building. The nearest object is a tree 20 ft. high 48 ft. distant. The Signal Service observer has a standard gauge; it is on the roof of a building 74 ft. above ground. Mr. Barker's gauge was at the surface, the top being 18 in. above ground.

St. Charles, St. Charles Co., Mo. Lat. 38° 45°; Lon. 90' 30': grade elevation 520 ft. J. R. Mudd, M.D., obs. M. W. S., Jan. 1878 to Dec. 1887. The top of the gauge is 5 ft. above ground. The nearest objects are two trees 10 ft. high about 10 ft. s.e. and n.e., a one-story stable 27 ft. w., and a house 9 ft. high 10 ft. n.w. of the gauge. Trees were set about four years ago. Previous to 1881 the gauge was exposed on an open space with no object nearer than 40 or 50 ft.

St. Joseph, Buchanan Co. Lat. 39° 46'; Lon. 94° 49': grade elevation 845 ft. Observer not known up to Dec. 1869. From Jan. 1870 to April 1873 Smithsonian Record, Schott. Robert Gunn obs., July 1874 to Dec. 1887.

Steelville, Crawford Co., Mo. Lat. 37° 57'; Lon. 91° 21': elevation 585 feet. E. A. Pinnell obs. M. W. S., Oct. 1884 to Dec. 1887. The gauge is on a hill side, n.e. exposure, the top being 6 feet above ground. The nearest objects are a house 30 ft. distant, the top of the house being 12 ft. above the gauge, and an apple-tree 10 ft. higher than the gauge 25 to 30 ft. s.

St. Louis, Mo., at Washington University. Lat. 38° 38' 03".8; Lon. 90° 12' 15".3: elevation 520 feet. F. E. Nipher, obs. M. W. S., Jan. 1878 to Dec. 1887. The gauge is in the rear yard of the dwelling-house on the s.e. cor. of 18th and Washington av. It was surrounded by houses and closed fences which protect the gauge from the wind: this, therefore, made it desirable to raise the gauge about 6 feet above ground in order to have it out of the way. When a gauge is exposed to the wind, the effect of raising the gauge above the ground is, as is well known, to cause it to lose some of the rain on account of the drifting effect of the wind. The gauge itself forms an obstacle, over the top of which the wind sweeps with a greater velocity than it would have done were the gauge not there, and the rain drifts to the leeward of the gauge. Hence gauges exposed to the wind should have the same altitude in order to be comparable. It is never good to expose a gauge on a small building in the country.

St. Louis—Signal Office. Up to Sept. 14, 1883, the gauge was exposed on the roof of the St. Louis Life Insurance Building, on 6th and Locust. Since that time it has been exposed on the roof of the Custom House. The standard gauge of the Civil Service is used.

St. Louis, Mo. Dr. George Engelmann. The observations were made at the residence of Dr. Engelmann. From 1836 to 1847 inclusive the gauge was exposed at the s.w. cor. of 2d and Chestnut sts.; from 1848 to Feb. 1868 inclusive the gauge was at the s.w. cor. of 5th and Elm sts.; from Mar. 1868 to Dec. 31, 1869, the rainfall was observed at 5th and Almond (now Valentine) sts.; from 1870 to 1881 the gauge was exposed at 3003 Locust st.

St. Louis, Mo. "Smithsonian Tables." This table of observation is from Mr. Schott's tables. The names of the observers are given on the table, but the localities of observation are not known.

St. Louis Waterworks. A. J. Chaphe and A. W. Grote obs., Jan. 1879 to Dec. 1887. M. W. S. gauge. The top of the gauge is 16 in. above the ground, with no tree nor building within 75 yds.

St. Louis, Mo. Tower Grove. ——— obs., June 1861 to June 1863.

Troy, Lincoln Co., Mo. Lat. 38° 56'; Lon. 90° 59'. J. A. Ward obs. M. W. S.

Unionville, Putnam Co., Mo. Lat. 40° 29′; Lon. 93° 03′. J. G. Hart obs. M. W. S., Jan. 1878 to May 1879; B. H. Bonfoey obs. M. W. S., Sept. 1879 to Jan. 1881.

Warrensburg, Johnson Co., Mo. Lat. 38° 45′; Lon. 93° 40′: grade elevation 870 ft. S. L. Goodwin obs. S., July 1868 to May 1875; W. L. Hedges obs. M. W. S., Jan. 1878 to Nov. 1878; Pres't Geo. L. Osborne obs. M. W. S., Dec. 1878 to Dec. 1881. The top of Mr. Osborne's gauge is about 20 ft. above ground. The nearest object is a house 15 ft. high 20 ft. n.e.

West Glaze, Camden Co., Mo. Lat. 37° 57′; Lon. 92° 35 : elevation 1450 ft. A. Y. Carleton obs. S., Jan. 1872 to Oct. 1878.

Wyaconda Prairie, Lewis Co., Mo., near Canton. G. P. Ray obs. S., Apr. 1862 to Dec. 1868.

STATIONS IN ADJOINING STATES.

Cairo, Ills. Lat. 37° 00′: Lon. 89° 10′ : elevation 377 ft. U. S. Signal Service obs. Record from Jan. 1872 to Dec. 1887, but only 10 years record here published. The top of the gauge is 78 ft. above ground, the exposure being on a building.

Keokuk, Iowa. Lat. 40° 23′; Lon. 91° 27′: elevation 584 ft. U. S. Signal Service obs. Record extends from July 1871 to Dec. 1887, but only 10 years published. The top of the gauge is 60 ft. above ground.

Leavenworth, Kansas. Lat. 39° 19′; Lon. 94° 58′: elevation 842 ft. U. S. Signal Service obs. The top of the gauge is 50 ft. above ground.

Mascoutah, St. Clair Co., Ills. Lat. 38° 32′; Lon. 89° 55′. Theo. Engelmann obs. M. W. S., Jan. 1878 to Dec. 1887. The gauge is of copper and was made in St. Louis; the diameter is 7.9 in., and is made after the Signal Service pattern, a measuring-stick being used. The top of the gauge is 3 feet above ground. The nearest objects are a building 100 ft. n.w., grapevines on trell ses 5½ ft. high 10 ft. n., cedar-trees 30 ft. high 40 ft. n.w. It is fastened between two stakes which do not reach the top of the gauge.

In the tables which follow there are first given a number of stations where the record covers more than ten years. Where this record covers the ten years ending December, 1887, the means for that period are in all cases separately reduced, and were used in the construction of the normal rain charts.

Next follows a series of stations where observations were begun with the ten-year period mentioned. Finally a series of fragmentary records are given, some of which have been taken from Mr. Schott's paper, and some being the records of our own observers who have not covered the entire ten years. These series were not used in constructing the normal maps. They were however used in constructing anew the rain maps of the individual months, in order to obtain interpolated values where observations were missing in the ten-year series.

An interesting question which suggested itself, was to compare the total amount of rainfall on the entire state, in cubic feet, with the amount of water flowing past the city of St. Louis in the Mississippi river during the same time.

In order to solve this problem, the map showing the normal annual rainfall was used. The map area of the whole State as determined by a planimeter was 0.443 square decimeter. The area of the whole state is given as 69,415 square miles. Hence if s be the planimeter area of any portion of the map of the State, the area square miles of that portion of the State represented will be

$$a = \frac{69,415}{0.443} s = 156693\ s.$$

Also if r = the annual rainfall in inches over any part of the state having a map area of s, the total fall of water in cubic feet per second on that area will be

$$R = \frac{69415 \times (5280)^2}{0.443 \times 12 \times 365 \times 86400} sr$$
$$= 11543\ sr.$$

The area of the regions bounded by the consecutive lines of equal rainfall and the boundary lines of the State were determined by planimeter. For instance, the region between the rain lines of 42″ and 44″ annual fall was 0.037 square decimeters. Over this area the rainfall was assumed to be 43″, as is shown in the table below. The fifth column of the table gives the number of square miles, where the rainfall has the value given in the corresponding place in column one. The total rainfall in the state in cubic feet per second is

$$R = 11543\ \Sigma sr$$
$$= 11545 \times 16.96$$
$$= 195.800.$$

The average annual rainfall in the state is

$$\frac{\Sigma sr}{0.443} = 38\ 28 \text{ inches,}$$

which is about the rainfall at St. Louis during the ten years.

Rainfall.	*r*.	*s*.	*sr*.	Square miles area.
Over 44″	45″	0.083	3.735	13.005
42 to 44	43	0.037	1.591	5.797
40 to 42	41	0.037	1.517	5.797
38 to 40	39	0.034	1.326	5.328
36 to 38	37	0.074	2.738	11,596
34 to 36	35	0.087	3.045	13 632
Over 38	38.2	0.014	0.535	2,194
32 to 34	33	0.043	1.419	6.738
Less than 32	31	0.034	1.054	5.328
		0.443	16.960	69.415

The river discharge at St. Louis was obtained by converting the average gauge readings for each month during the ten years into cubic feet per second, by means of the discharge-curve constructed by the Missouri River Commission. This is not quite accurate as discharge is not a linear function of gauge reading, so that fluctuations of level during the month are not properly represented. The error, however, will not be more than a few per cent., and will not at all affect the general conclusions which will be reached.

The following table gives the river discharge for each month, the unit being 1,000 cubic feet per second. Thus in January, 1878, the average flow of water was at the rate of 108,000 cubic feet per second, etc.

RIVER DISCHARGE AT ST. LOUIS.

Year.	Jan.	Feb.	Mar	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	108	159	221	210	311	388	294	208	102	105	98	83	2.287
1879	86	78	105	162	132	213	240	149	87	81	112	90	1 535
1880	130	79	109	189	202	267	358	146	136	105	74	59	1.854
1881	84	121	262	499	506	340	318	127	112	308	435	235	3 347
1882	139	177	245	313	392	485	455	171	98	86	112	68	2.741
1883	70	198	299	223	349	565	378	198	85	94	127	79	2.665
1884	106	149	179	398	312	270	221	138	128	272	136	93	2.402
1885	156	115	235	304	312	367	275	208	237	106	114	64	2.493
1886	170	233	237	337	370	210	129	77	68	72	63	51	2,017
1887	88	149	217	210	204	179	161	81	86	70	58	53	1 556
Sum	1137	1458	2109	2845	3090	3284	2829	1503	1139	1299	1329	875	22,897

The average river discharge during the ten years ending Dec. 31, 1887, as appears from the above table, was

$$\tfrac{1}{12}\ 2,289,700 = 190.800 \text{ cubic ft. per second.}$$

The amount of water falling per second upon the whole state during the same interval was

195,800 cubic ft. per second.

It thus appears that if all the rain which falls upon Missouri alone were to be fed into the rivers it would yield a greater flow than we have in the Mississippi river at St. Louis.

The writer has now under examination the comparison between the total rainfall on the basin draining past St. Louis, and the river discharge at this point. At present it will be sufficient to compare the total area drained with the area of Missouri. This area was measured on 59 of the monthly rain maps of the Signal Service, and found to be 0.4429 square decimeters with a probable error of ± 0.0002. By a singular coincidence, this is the same as our map area of Missouri. The scale of the map was determined by measuring on the same maps the area of Missouri, Kansas, Nebraska, and Iowa, which was found to be 0.1718 square decimeters.

The areas of those States are given as follows:

Missouri	69,415	square	miles.
Kansas	82,080	"	"
Nebraska	76,855	"	"
Iowa	56,025	"	"
Total	284 375	"	"

Hence the drainage area of the Mississippi and Missouri rivers above St. Louis is 733,120 square miles, or over ten times the area of Missouri.

FUTURE WORK OF THE SERVICE.

It is very much to be regretted that it seems to be impossible for us to make a careful study of local summer rain-storms. These are the storms which most vitally affect the agriculturist, and it is certain, that, with the general extension of the telephone among farmers, there will be developed a sysetm of harvest storm-warnings. This matter was urged upon the Legislature of 1882, and it has again been brought to their attention in 1889. There seems to be no probability that Missouri will be the first to inaugurate a system which will result in such profound and lasting advantages. It is simply out of the question for private citizens to carry on such work as this at their own expense, and it also seems to be out of the question to secure the organization of a state weather service by simply making a dignified presentation of the advantages of such a service.

Station Boonville, Cooper County, Mo.

Year	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1875	......	....	.. ..	....	.. ..	.. ..	......	3.30	.....	1.10	0.67	1.71	......
1876	1.49	0.68	2.45	2.25	1.90	2.04	6.27	3.73	2.05	1.56	3.49	0.20	28.11
1877	*1.65	0.42	4.90	1.16	4. 3	10.19	2.95	3.80	3.90	7.58	2.28	4.26	47.12
1878	1.02	4.57	5.11	4.55	7.92	3.57	2.52	2.42	1.43	1.02	0.63	2.45	37.21
1879	0.92	0.95	0.58	2.18	1.94	10.84	3.32	0.05	2.88	0.74	2.33	1.83	28.56
1880	0.90	2.08	1.10	2.93	6.80	4.88	4.82	4.38	2.04	1.62	1.79	1.24	34.58
1881	0.19	4.89	3.93	2.35	3.37	6.14	1.05	1.51	5.98	6.09	5.98	2.39	43.87
1882	1.95	6.04	2.58	6.26	6.48	7.82	5.42	2.12	2.72	8.43	2.71	2.32	54.85
1883	1.33	1.89	1.96	1.45	5.10	†8.50	2.49	0.79	0.25	6.47	1.93	1.14	33.30
1884	1.24	*2.99	3.00	1.80	5.61	4.42	6.83	2.94	10.13	3.28	2.40	2.59	47.23
1885	1.53	2.62	0.68	2.95	5.94	5.75	6.52	2.91	9.96	2.82	2.64	1.27	45.59
1886	4.00	2.14	2.00	5.19	4.16	8.19	1.05	3.48	8.96	2.21	2.77	0.78	44.93
1887	1.99	4.42	1.52	4.47	4.57	5.61	2.89	0.93	3.58	*1.60	0.79	3.00	35.37
10 yrs.	1.51	3.26	2.25	3.41	5.19	6.57	3.69	2.15	4.79	3.43	2.40	1.90	40.55
Average normals for 12 years.	1.52	2.81	2.48	3.13	4.82	6.50	3.84	2.42	4.49	3.62	2.48	1.96	40.06

* For 26 days only. † Approximated.

Station Corning, Holt County, Mo.

Year	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1870	......	.....	.. ..	2.10	......	....	......	4.40	4.73	5.65	0.45	0.35	.....
1871	0.98	1.93	0.45	0.45	1.25	2.79	3.92	2.20	0.95	1.46	1.31	0.75	18.44
1872	0.50	0.30	1.29	2.63	5.38	3.30	4.37	1.00	2.30	1.53	*0.30	0.33	23.23
1873	1.25	0.15	0.40	2.40	3.75	3.63	1.55	0.75	1.10	0.90	0.20	*3.00	19.08
1874	2.43	0.74	2.12	1.10	0.45	3.90	0.75	1.10	5.25	0.35	1.75	1.05	20.99
1875	0.30	1.43	1.33	1.15	2.00	4.45	9.10	3.60	2.75	1.40	0.02	2.15	29.68
1876	0.87	0.25	6.50	5.15	4.90	5.40	3.70	3.95	2.97	1.41	2.82	0.01	37.93
1877	0.70	0.90	1.50	6.75	7.10	5.07	2.60	3.82	1.90	4.20	2.10	1.30	37.94
1878	1.25	1.37	3.45	2.86	4.68	6.30	3.23	0.40	2.33	3.75	0.87	1.03	31.52
1879	0.87	1.00	0.62	2.20	2.55	5.80	5.27	1.81	5.27	1.43	6.18	1.84	34.84
1880	0.13	0.35	0.55	2.50	4.12	3.75	4.99	12.61	2.46	2.88	1.34	0.60	36.28
1881	1.19	4.71	1.67	1.77	5.03	4.70	1.45	2.97	6.73	6.91	1.86	0.73	39.72
1882	0.23	0.73	2.15	4.80	3.63	*4.50	*2.00	1.09	0.40	5.24	1.64	1.65	28.06
1883	0.71	2.00	0.57	2.15	7.68	*16.50	3.37	1.83	1.44	*6.00	*1.00	*0.75	44.00
Normals for 13 years.	0.88	1.22	1.74	2.76	4.04	5.39	3.56	2.85	2.76	2.88	1.65	1.17	30.90

* Approximate. † 1870 not considered in normals.

Station Hermann, Gasconade County, Mo.

Year.	January.	February	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Year.
1874	*2.02	2.94	*3.21	*3.32	*3.95	*4.92	2. 8	6.19	4.38	2.50	4.16	1.32	41.80
1875	*2.02	*2.88	5.64	4.48	4.73	6.45	11.84	2.57	0.46	1.89	1.11	1.77	45.84
1876	4.24	3.09	5.98	3.18	3.28	8.11	4.75	4.21	5.21	0.61	2.75	*2.83	48.24
1877	*2.02	0.71	3.50	2.46	3.47	5.71	1.44	2.25	1.54	7.97	3.68	3.56	38.31
1878	2.08	2.18	5.24	6.52	4.71	2.15	4.86	3.50	2.81	2.04	1.46	2.51	40.06
1879	2.04	1.03	2.73	2.76	2.14	5.70	1.20	1.26	4.24	1.77	5.36	2.37	32.60
1880	1.80	1.99	1.34	3.74	3.51	3.45	3.97	3.97	2.07	2.26	2.12	1.99	32.21
1881	0.19	4.16	3.71	1.17	3.72	2.15	2.01	0.20	6.26	5.58	4.16	1.36	35.67
1882	2.51	6.66	2.15	3.65	5.57	5.11	4.35	3.16	3.38	3.99	2.53	2.42	45.48
1883	1.64	5.11	2.67	1.02	†3.50	3.80	0	0.45	1.55	0.41	3.94	3.52	27.61
1884	0.41	3.86	3.52	2.32	3.26	7.04	8.20	3.12	7.74	1.89	3.14	2.28	46.78
1885	2.97	0.89	0.85	4.47	3.91	5.04	2.96	4.71	8.73	2.45	1.78	1.90	40.66
1886	3.15	1.56	1.96	2.98	4.98	7.24	0	2.75	4.75	0.86	2.83	1.15	34.21
1887	1.16	3.30	2.42	3.39	4.61	2.01	1.94	2.85	4.48	0.28	2.42	2.13	30.54
10 years average	1.80	3.07	2.66	3.30	3.99	4.37	2.90	2.60	4.60	2.15	2.97	2.16	36.58
Normals for 14 yrs.	2.02	2.88	3.21	3.32	3.95	4.92	3.56	2.94	4.11	2.46	2.96	2.22	38.57

* Normal substituted. † Approximated.

Oregon, Holt County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1855....			....	....	....	.. ..	6.75	8.50	2.45	1.75	2.90	1.65	.....
1856....	2.55	2.05	1.30	3.66	3.10	4.00	6.35	6.00	2.10	1.80	1.80	1.95	36.60
1857 ...	1.35	1.75	2.65	1.05	3.05	3.50	3.20	6.10	3.30	3.25	3.05	1.15	33.40
1858....	1.10	3.10	2.40	5.40	8.35	7.00	6.65	2.10	0.95	2.50	2.05	1.55	43.15
1859....	2.00	2.60	3.75	6.35	11.65	6.70	4 75	4.45	2.90	1.15	1.80	1.15	49.25
1860....	1.55	1.30	0.20	0.90	3.25	4.30	2.17	2.40	2.85	0.75	1.05	2.40	23.12
1861....	5.20	1.75	1.70	1.20	7.30	7.85	3 95	3.35	3.40	3 05	1.00	1.25	41.00
1862....	2.28	1.15	2.47	6.05	4.50	0.95	2.55	5.30	3 60	2.50	1.10	1.85	34.30
1863 ...	1.60	2.21	1.10	2.93	3.48	5.55	4.00	6.75	1.70	2.00	2.30	3.85	37.47
1864 ...	1.17	0.14	2.67	3.11	3.53	4.35	2.60	6.05	4 55	2.08	2.05	0.92	30.22
1865....	0.50	3.39	1.61	6.70	2.30	9.00	5.80	7.70	2.50	1.45	0.70	1.80	43.45
Sum ...	19.30	19.44	19.85	37.29	50.51	50.20	42.02	50.20	27.85	20.53	16.90	17.87	371.96
10 years' mean	1.93	1.94	1.98	3.73	5.05	5.02	4.20	5.02	2.78	2.05	1.69	1.79	37.20
1866....	2.81	1.01	1.52	3.37	4.43	5.75	3.90	3.26	7.61	2.38	1.60	4.99	42.63
1867....	2.08	4.89	2.95	2.48	5.84	4.10	12.24	2.95	3.20	2.10	0.40	1.40	44.63
1868 ...	1.00	1.55	3.60	3.43	3.50	3.51	4.22	3.02	2.87	1.68	3.05	2.17	33.60
1869 ...	2.06	2.51	1.28	3.31	4.42	7.49	5 74	6.90	3.28	1.24	1.49	1.46	41.18
1870 ...	1.00	0.03	2.30	1.99	2 70	1.27	0.76	8.44	4.20	6.14	0.35	0.45	29.63
1871....	1.27	3.11	0.56	2.14	2.13	2.30	4.50	3.40	1.13	2.42	3.16	2.42	28.54
1872....	0.20	0.67	2.63	3.85	6.50	3.84	6.71	3.97	3.55	2.46	0.26	1.11	35.75
1873 ...	2.76	0.29	0.76	4.15	3.79	3.33	2.18	2.05	3.18	0.79	1.13	3.00	27.41
1874 ...	1.86	1.10	2.38	2.85	2.39	5.49	2.73	1.86	6.15	1.47	2.83	1.22	32.33
1875 ...	0.55	2.25	1.80	1.31	2.14	5.13	6.45	4.98	3.58	1.42	0.18	2.51	32.30
1876 ...	0 72	0.48	5 35	4.61	5.25	4.30	4.70	6.04	2.62	4.02	3.18	0.15	41.42
1877....	1.50	1.01	2.99	7.32	5.20	5.00	2.45	5.36	*2.00	4.54	1.88	2.09	41.34
1878 ...	1.58	1.36	1.84	2.65	3.48	4.82	7.18	0.84	3.59	3.07	0.87	2.19	33.47
1879 ...	1.26	0.48	0.52	3.30	3.09	6.95	6.98	1.70	3.11	2.49	7.81	1.37	39.06
1880 ..	1.58	0.61	0.79	2.96	5.52	3.70	4.81	6.61	2.89	1.89	1.66	1.16	34.18
1881....	1.14	5.25	2.34	2.57	6.14	5 28	1.22	2.66	4.49	6.27	3.32	1.30	41.98
1882 ..	0.71	0.89	1.82	5.80	3.52	4.01	4.64	0.67	0.74	6.33	2.03	1.58	32.74
1883 .	1.70	3.34	0.72	3.31	4.79	14 94	5.95	1.59	2.15	6.50	1.08	0.84	46.91
1884....	1.45	1.08	2.34	3.76	5 18	5.49	6.35	3.63	4.01	3 26	0.72	1.60	38.87
1885...	1.70	1.57	0.40	5.77	1.90	4.34	2.87	0.82	3.62	5.18	0.48	0.92	29.57
1886 ..	3 03	0.98	2.71	3.23	2.58	4.34	0.20	2.06	3.66	5.41	1.29	0.81	30.30
1887....	1.42	4.48	1.48	2.15	3.96	3.08	1.65	5.31	4.97	1.85	0.95	1.91	33.21
Sum	33.28	38.94	43.08	76.31	88.45	108.46	98.43	78.12	76.60	72.91	39.72	36.65	791.05
Mean for 22 yrs.	1.52	1.77	1.96	3.47	4.02	4.93	4.47	3.55	3.48	3.32	1.81	1.67	35.97
10 years' average	1.56	2.00	1.50	3.55	4.02	5.70	4.18	2.59	3.32	4.22	2.02	1.37	36.03
Normal for 32 years..	1.65	1.82	1.97	3.55	4.34	4.96	4.39	4.01	3.26	2 92	1.77	1.70	36.34

* Approximate. 1855 not considered in normals.

Rolla, Phelps Co., Mo.

Year.	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1866	*2.08	*2.21	*3.43	6.12	2.85	2.37	6.36	1.50	13.75	2.18	0.58	1.10	44.57
1867. ..	1.92	3.70	2.40	*4.48	7.32	1.09	6.62	1.25	0.26	1.50	2.08	1.44	34.06
1868	1.33	0.29	6.59	7.10	3.39	3.25	1.87	7.15	4.85	1.34	1.47	2.56	41.19
1869......	2.06	1.57	3.24	4.47	5.66	6.09	4.09	5.52	2.31	2.53	5.05	1.62	44.12
1870 ..	1.18	1.06	4.64	2.64	0.68	2.73	3.99	5.64	2.33	3.56	2.55	2.44	33.44
1871 ...	3.23	2.86	2.31	1.53	4.52	2.24	4.90	5.44	0.05	2.98	1.69	1.69	33.35
1872......	1.88	1.82	2.59	3.52	5.50	3.27	6.18	1.76	2.42	0.60	1.36	1.20	32.10
1873	4.61	2.39	1.92	5.17	3.14	4.01	3.42	1.38	4.51	2.19	1.04	6.02	39.71
1874.. .	1.95	3.83	3.44	3.57	3.01	3.89	2.04	2.14	2.08	2.45	4.60	1.95	31.95
1875	0.69	2.45	4.00	6.20	8.20	5.35	12.25	2.85	0.15	3.85	1.80	2.65	59.35
1876	6.75	1.65	5.30	5.89	4.11	9.99	....	...	....	..	...	....	...
1877......	0.69	....	1.30	....	...	...	...	....	....	....	....	....	....
Normals for ten years.	2.08	2.21	3.46	4.48	4.43	3.43	5.16	3.46	3.27	2.32	2.22	2.26	38.78

1876-1877 not considered in normals. * Normals substituted.

Springfield, Greene County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1877	†1.75	1.15	4.76	6.95	8.55	15.29	2.45	6.60	1.99	7.95	4.75	3.20	65.21
1878	1.99	2.07	3.27	6.04	7.25	5.19	4.86	4.43	1.05	3.00	0.52	1.92	41.59
1879......	1.82	0.66	1.40	2.61	2.59	2.85	1.18	1.50	0.68	0.97	4.62	4.15	25.06
1880......	0.87	2.97	2.58	5.10	4 20	4.05	4.59	*3.00	*2.00	2.00	3.05	0.89	35.12
1881......	*1.59	*3.00	*3.00	*2.00	*5.00	*4.50	*1.50	*2.50	*3.50	*7.00	*3 50	*2.00	39.00
1882	2.65	7.29	3.19	3.71	8.07	2 70	4.98	2.14	4.48	7.62	6.30	2.30	55.43
1883	1.05	5.65	1.68	3.11	7.39	*6.00	*7.00	*3.00	*0.40	*7.50	*2.00	*2.50	47.19
1884	*0.70	*3.29	*2 09	*4.20	5.48	2.67	9.22	3.17	3.80	1.73	3.03	7.62	46.82
1885	2.80	1.05	2.10	5·01	3.29	5.15	9.14	3.73	6.15	1.75	2.05	1.50	43.72
1886	1.55	3.43	1.59	2.90	9.30	*6.00	1.75	2.60	3.49	0.40	*1.60	0.75	35.18
1887......	2.60	4.10	2.50	2.89	4.60	6.65	2.63	3.29	2.43	2.08	3.27	2.39	39.34
Ten yrs. averages.	1.75	3.34	2.32	3.75	5.71	4.58	4.68	2.94	2.79	3.49	2.99	2.59	40.84
Normals for eleven years.	1.75	3.14	2.54	4.04	5.97	5.54	4.47	3.27	2.71	3.82	3.15	2.65	43.06

† Normal substituted. * Approximated.

St. Joseph, Buchanan County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1869	1.28	1.98	1.04	4.00	5.85	10.65	8.40	5.41	.	...	...	2 20	....
1870	0.45	0.00	1.45	2.20	3.80	....	....	8.30	....	...			....
1871	.	....	....	....	....	...	....		....	..	3.10	0.76	....
1872	0.20		....	...	2.50	4.50	6.80	6.05	1.90	2.30	....	1.49	....
1873	1.90	0.10	....	3.60	..	....	....			....	....	...	....
1874	....	....			....	...	0.80	1.55	7.10	0.60	1.71	0.74	....
1875	1.00	1.15	1.82	1.82	4.14	7.79	6.82	4.89	1.97	1.54	0.12	1.88	34.94
1876	1.42	0.18	4.77	8.30	6.18	5.42	2.40	6.36	3.02	1.84	2.93	0.05	42.87
1877	0.55	1.11	3.99	5.00	7.50	12.35	4.32	6.32	5.47	5.99	2.17	2.36	57.13
1878	2.18	1.93	2.33	2.19	4.86	5.06	4.68	3.55	3.30	2.13	1.13	1.92	35.26
1879	1.50	0.40	0 17	3.03	1.39	11.09	9.55	0.73	2.64	3.34	8.45	1.92	44.21
1880	1.64	0.48	2.32	2.38	3.81	1.05	2.12	6.98	2.07	2.00	1.48	0.79	27.12
1881	0.62	3.27	1.37	4.03	4.35	*6.00	1.86	2.14	3.29	12.24	2 80	1.30	43.27
1882	1.14	1 09	1.93	4.11	3.51	2.26	4.83	0.51	0.46	3.92	2.11	0.87	26.74
1883	1.17	3.33	0.50	2.48	5.29	8.16	4.15	2.28	1.35	*7.00	*1.50	*1.00	38.22
1884	0	*1.20	2.12	1.66	2.97	2.58	3.39	3.31	3.22	0.62	1.00	0.54	22.61
1885	0.29	0.40	*0.40	2.55	3.65	3.16	0.95	3.37	3.61	4.16	0.95	0.46	23.95
1886	*2.00	*0.50	*2.00	*2.30	4.20	5.64	0.42	0.73	5.41	3.30	0.76	*0.50	27.76
1887	0.16	0.48	1.50	*2.00	2.26	4.40	1.50	*6.00	3.13	1.47	1.13	0.70	24.73
Ten yrs. averages.	1.07	1.31	1.46	2.67	3.63	4.94	3.34	2.96	2.85	4 02	2.13	1.00	31.39
Normals for 13 yrs.	1.05	1.19	1.94	3.22	4.16	5.77	3.61	3.63	3 00	3.81	2.04	1.10	34.52

* Approximate.

St. Louis Signal Service Records.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1871	2.56	2.86	1.31	0.45	3.13	2.51	1.50	2.97	0.25	2.07	1.83	1.17	22.61
1872	0.61	1.15	2.43	2.77	5.97	4.28	4.59	0.93	3.38	0.55	2.01	1.70	30.40
1873	3.53	1.52	2.10	6.87	5.27	6.68	5.96	0.07	3.02	3.27	1.64	5.10	45.03
1874	3.14	3.66	4.36	3.44	3.70	2.00	5.71	4.70	2.50	1.09	2.32	1.46	37.88
1875	0.54	2.59	4.08	2.53	5.48	10.84	9.49	2.66	0.24	1.23	0.89	2.42	42.99
1876	4.75	2.86	6.90	2.25	3.13	6.43	5.18	5.03	7.63	1.66	1.74	0.18	47.74
1877	1.24	0.88	3 41	2.86	3.11	8.69	2.88	2.61	3.56	4.92	3.76	3.34	41.26
1878	2.36	1.69	2.79	6.74	4.63	2.40	3.92	4.75	3.42	3.27	1.38	3.48	40.83
1879	1.64	1.48	1.92	2.31	0.95	4.64	1.97	2.23	1.34	0.68	4.30	2.84	25,70
1880	3.83	2.65	2.51	3.31	3.44	2.46	5.17	1.53	3.10	2.09	2.67	1.80	34.56
1881	0.49	4.16	1.95	3.14	3.96	2.74	2.13	0.31	3.14	7.21	6.74	1.40	37.37
1882	2.80	8.94	3.49	3.58	4.55	4.53	3.84	2.20	1.73	2.44	3.24	1,81	43.15
1883	0.94	5.88	2.29	3.31	2.89	5.04	4.31	3.34	0.01	6.60	3.71	1.78	40.10
1884	0.79	4.43	3.00	4.15	2.68	4.52	2.86	1.21	6.04	2.48	2.30	6.18	40.64
1885	3.26	0.87	0.40	4.84	2.80	7.68	2.58	2.96	8.98	7.51	1.68	2.03	45.59
1886	3.11	1.71	3.04	2.10	7.84	7.09	0.55	2.44	9.60	0.85	3.36	2.65	44.34
1887	0.65	3.68	3.54	4.36	5.27	2.54	2.74	1.14	2 47	0.76	4.61	3.54	35.30
Ten yrs. average.	1.99	3.55	2.49	3.78	3.90	4.30	3.01	2.21	3.98	3.39	3.40	2.75	38.76
Normals for 17 yrs.	2.13	3.00	2.91	3.47	4.05	4.97	3.84	2.42	3.54	2.86	2.83	2.52	38.56

Jefferson Barracks, St. Louis County, Mo.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November	December	Year
1840....	....	....	..		....		4.97	12.25	5.16	5.79	1.28	0.55	....
1841.....	2.08	1.30	4.58	4.39	1.95	1.34	1.88	2.51	1.99	6.76	1.08	3.68	36.54
1842....	0.44	3.46	2.93	2.02	4.81	5.81	1.77	1.99	0.66	2.03	1.58	1.77	29.18
1843	2.27	1.75	2.30	4.52	3.01	2.12	2.60	0.97	5.76	1.65	4.16	1.47	32.58
1844.....	2.19	2.33	2.50	3.13	7.27	5.40	5.23	0.71	1.80	1.06	4.16	1.19	37.27
1845....	4.18	0.84	3.24	1.71	3.25	9.78	3.89	4.53	1.71	0.63	1.35	0.80	32.91
1846....	3.60	1.02	1.73	4.83	3.50	2.86	0.45	2.09	3.47	0.82	1.42	10.22	36.01
1847.....	*2.40	*2.30	3.12	*4.00	*4.30	4.10	4.47	*1.00	0.85	*8.00	*8.00	0.23	42.77
1848.....	1.83	0.92	1.91	1.50	2.58	7.33	4.01	4.20	2.90	1.55	2.28	4.01	35.05
1849.....	3.41	0.37	2.77	1.53	2.40	5.85	7.70	4.72	4.84	1.85	2.02	1.52	38.58
1850	1.65	3.22	4.66	5.02	3.46	1.52	2.95	5.20	2.75	1.75	4.11	3.32	39.61
1851.	0.40	5.05	1.86	2.80	3.97	5.64	4.65	7.06	0.81	2.26	0.38	1.25	36.13
1852	3.34	1.73	7.19	1.39	8.12	11.85	2.72	3.24	2.97	4.81	3.80	3.97	55.13
1853	0.57	1.51	0.85	3.53	3.52	3.19	6.90	7.08	4.29	1.10	2.40	1.23	36.08
1854.....	1.90	3.25	6.90	3.40	6.98	4.19	0.96	1.47	3.41	6.57	3.13	1.11	43.27
1855. .	4.99	0.93	3.98	1.71	4.70	2.71	7.78	3.48	4.09	4.61	4.50	*3.00	46.18
1856	*1.00	*3.60	*1.00	*6.00	3.95	3.80	2.15	5.93	3.20	2.41	6.07	3.02	42.13
1857.....	0.20	2.23	1.20	2.12	1.22	7.11	5.95	2.77	5.85	5.18	5.00	2.18	41.01
1858.....	3.35	1.51	1.32	2.65	6.62	6.39	7.67	1.87	4.27	6.57	3.91	3.80	49.96
1859....	2.41	6.10	2.90	3.20	11.28	7.83	3.80	3.40	3.26	1.01	4.01	2.35	51.58
1860 ...	2.03	2.13	0.98	5.62	3.91	1.06	9.61	0.65	5.09	2.16	4.63	2.21	40.08
1861.....	4.50	2.65	4.49	4.42	7.35	5.19	6.70	4.90	2.92	4.50	3.25	0.99	51.86
1862.....	2.99	1.12	1.76	....	....	4.30	11.45	....	...	....	...	....	....
1882. ..	2.80	6.96	2.14	3.17	4.89	3.80	4.30	3.52	1.71	2.42	4.00	1.16	40.87
1883	0.59	2.79	2.95	2.99	2.09	4.90	4.73	3.37	†0.00	3.81	3.30	0.39	....
1884. ..	0.55	2.10	3.00	1.90	2.64	2.60	2.68	....	...	....	....	....	....
Nominals for 21 yrs.	2.18	2.30	2.97	3.31	4.65	5.00	4.47	3.32	3.18	3.20	3.55	2.54	40.68

* Approximated. † Estimated.

St. Louis, Mo., Smithsonian Series. Lat. 38° 37′; Lon. 90° 12′. Elevation 481 ft.

Year.	January	Febr'y.	March.	April.	May.	June.	July.	August	Sept.	October	Nov.	Dec.	Year.	Authority.
1836	......	......	......	......	......	......	3.66	6.51	5.90	2.59	4.20	5.02	......	Ass't Surgeon.
1837	0.84	1.35	3.13	2.34	3.00	3.46	2.48	2.73	2.85	0.79	1.96	2.01	26.94	Dr. G. Engelmann.
1838	3.71	1.88	1.35	2.68	1.63	3.70	2.57	4.13	0.53	1.73	1.94	0.37	26.22	A. Wislizenus.
1839	1.82	2.45	2.44	4.30	7.67	7.23	5.45	2.20	2.42	3.96	2.48	2.00	44.42	B. D. Kribben.
1840	1.16	1.29	2.84	3.31	4.58	6.27	2.36	7.15	3.96	4.49	2.27	0.53	40.21	J. H. Luenemann.
1841	0.99	0.49	5.35	3.71	1.79	2.80	3.36	3.79	2.86	7.12	5.44	3.48	41.18	C. J. B. Leib.
1842	0.45	3.90	2.21	3.48	3.22	5.12	1.76	2.64	2.17	2.57	2.38	2.39	32.29	J. Stratmann.
1843	2.14	1.60	2.89	4.75	4.55	3.74	3.31	1.04	2.11	1.52	3.66	1.61	32.92	B. B. Brown.
1844	4.12	2.75	4.03	4.71	11.15	7.19	8.12	0.96	0.17	2.46	0.83	1.97	48.46	G. Prender.
1845	1.48	1.40	3.61	2.98	3.73	11.88	2.39	6.84	0.81	1.53	1.42	0.67	38.74	A. Fendler.
1846	2.59	1.73	2.16	6.22	4.86	5.07	1.03	2.70	5.56	3.52	3.15	12.23	50.82	
1847	1.95	3.34	3.31	6.12	5.15	10.04	5.34	0.82	3.06	9.41	9.34	1.01	58.89	
1848	1.41	2.61	6.09	3.04	9.02	18.02	5.46	6.53	1.15	3.37	1.91	5.50	64.11	
1849	5.88	0.56	3.15	3.36	4.55	11.08	11.53	6.55	4.89	2.48	2.73	1.86	58.62	
1850	2.02	3.55	5.26	6.76	5.44	0.82	3.96	1.63	2.97	2.58	5.45	2.38	42.82	
1851	0.45	7.03	2.44	4.00	2.54	5.00	1.58	7.69	0.58	1.51	2.39	3.43	38.64	
1852	1.10	1.80	7.83	2.11	4.82	9.04	2.20	1.86	1.31	5.00	3.02	3.19	43.28	
1853	0.55	1.90	0.84	3.46	3.25	3.41	4.13	5.21	4.14	1.03	1.18	0.71	29.81	
1854	0.91	2.76	7.30	5.95	5.47	2.70	1.31	1.64	1.40	3.57	1.70	1.19	35.90	
1855	4.44	1.04	5.02	2.41	7.89	4.26	5.61	5.69	3.50	4.07	4.98	3.07	51.98	
Normals (for 19 yrs.)	2.00	2.28	3.75	3.98	4.96	6.36	3.89	3.78	2.44	3.30	3.06	2.61	42.43	

1836 not considered in normals.

St. Louis, Mo. Dr. G. Engelmann's Record.

Year	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Win.	Spr.	Sum.	Aut.	Year
1838....	3.72	1.25	1.51	3.35	4.68	3.73	3.13	4.48	0.06	3.06	2.09	0.41	....	9.55	11.34	5.21	31.51
1839 ..	2.21	2.50	2.59	5.15	7.93	7.26	5.71	2.89	2.45	3.96	2.18	2.00	5.15	15.98	15.86	8.89	47.44
1840 ...	1.80	1.38	2.10	3.31	4.58	6.27	2.36	7.15	3.96	6.39	1.73	0.71	5.18	9.99	15.78	11.99	41.65
1841....	6.81	0.88	4.99	3.85	2.38	1.67	3.09	5.63	3.22	6.81	5.44	3.93	2.43	11.22	10.39	15.47	42.73
1842 ...	0.45	3.90	2.21	3.48	3.22	5.12	1.76	2.64	2.17	2.57	2.38	2.39	8.28	8.91	9.52	7.12	32.29
1843 ...	2.34	1.90	3.49	4.87	4.15	3.95	2.49	1.32	2.19	1.55	4.82	1.72	6.63	12.51	7.76	8.56	34.79
1844 ..	3.36	1.73	4.81	3.86	11.26	6.85	8.13	0.45	0.30	2.25	1,17	1.61	6.81	19.96	15.43	3.72	45.81
1845 ...	1.83	1.07	3.18	2.28	4.22	10.01	4.75	6.23	1.03	1.16	1.10	0.93	4.51	9.88	20.99	3.29	37.99
1846 ...	2.98	1.27	1.27	4.84	3.75	5.21	0.84	4.73	4.84	2.71	2.11	10.90	5.18	9.86	10.78	9.66	45.45
1847 ...	2.12	3.58	2.28	3.98	4.36	8.61	5.37	0.94	3.26	8.74	8.63	0.89	16.60	10.62	14.88	20.63	52.72
1848 ...	1.86	2.27	6.61	3.16	8.10	17.07	5.37	9.74	1.12	2.41	1.91	5.74	5.02	17.87	32.18	5.44	65.36
1849....	4.18	0.56	2.70	2.64	2.71	6.46	9.40	5.15	5.81	2.17	2.11	1.82	10.48	8.05	21.01	10.09	45.71
1850 ..	1.94	4.10	5.63	7.68	7.47	1.47	4.83	2.10	3.71	2.71	6.24	2.59	7.86	20.78	8.40	12.69	50.50
1851 ...	0.61	6.74	3.14	4.70	2.83	6.49	1.77	8.97	0.49	1.51	1.99	3.90	9.91	10.67	16.93	3.19	42.84
1852 ...	0.99	2.12	7.67	2.28	5.19	10.25	3.36	1.69	1.47	5.26	3.29	3.48	7.01	15.14	15.21	10.02	46.96
1853 ...	0.52	1.67	0.79	3.24	3.64	3.23	4.10	5.48	4.67	0.96	1.51	1.08	5.67	7.67	12.81	7.14	30.89
1854 ...	1.18	3.11	7.49	7.60	6.30	3.21	0.92	1.80	1.41	4.15	1.94	1.49	5.37	21.39	5.93	7.53	40.63
1855 ...	1.66	0.70	2.89	2.65	7.46	4.27	5.17	6.53	3.89	3.89	5.16	3.10	6.85	13.00	15.97	12.94	50.37
1856 ...	1.03	3.64	1.06	6.35	3.03	1.24	4.61	6.32	3.51	2.10	4.90	4.29	7.77	10.44	12.17	10.51	42.08
1857...	0.41	7.74	1.80	1.72	4.81	3.71	2.82	1.15	3.18	3.02	3.80	1.87	12.44	8.33	10.68	10.00	39.03
1858...	3.42	2,12	3.96	6.07	10.64	6.69	8.03	2.87	3.86	7.73	4.92	8.52	7.41	20.67	17.59	16.51	68.83
1859....	2.32	5.35	7.32	4.89	6.60	11.02	5.54	2.93	4.44	1.80	5.43	3.76	16.19	18.31	19.49	11.67	61.40
1860....	1.89	2.60	1.16	2.03	2.29	6.58	2.97	2.96	2.11	1.58	1.63	2.08	8.16	5.48	12.51	5.32	29.79
1861	1.16	2.01	7.38	3.18	4.39	4.96	2.04	3.44	4.11	2.85	1.39	1.09	5.25	14.95	10.44	8.38	38.03
1862....	4.01	0.80	4.11	4.82	2.51	2.85	3.61	1.32	6.27	3.73	3.59	6.38	5.90	11.44	7.78	13.59	44.00
1863....	4.11	3.99	3.02	1.55	2.68	3.16	2.51	6.93	1.56	4.76	2.15	4.03	14.48	7.25	12.60	8.47	40.45
1864 ..	2.74	0.82	1,71	5.58	3.90	0.41	3.60	4.91	2.82	3.15	5.25	2.72	7.59	11.19	8.92	11.22	37.61
1865....	0.87	3.75	8.61	3.31	5.66	5.21	7.94	1.96	2.60	3.33	0.00	3.63	7.34	17.58	15.11	5.93	46.87
1866....	4.16	2.24	2.80	1.56	2.24	5.59	3.67	5.16	10.53	2.01	1.37	1.87	10.03	6.60	14.42	13.91	43.20
1867....	2.28	4.81	2.37	0.53	8.26	5.64	3.71	2.29	0.17	1.31	2.74	3.65	8.96	11.16	11.64	4.22	37.76
1868....	1.71	0.55	7.66	7.08	3.96	1.58	2.03	8.53	5.25	2.11	2.04	3.09	5.91	18.70	12.14	9.40	45.59
1869....	2.02	2.49	4.24	4.61	3.60	6.25	2.49	5.51	1.70	3.42	7.48	3.16	7.60	12.45	14.25	12.60	46.97
1870*...	2.00	1.00	2.00	2.55	1.93	1.38	1.59	6.55	1.14	3.35	1.94	2.76	6.16	6.48	9.52	6.43	28.19
1871....	3.60	2.64	1.14	0.25	3.40	2.87	1.14	3.00	0.02	1.75	1.21	0.85	9.00	4.79	7.01	2.98	21.87
1872....	0.79	1.69	1.70	2.85	6.57	4.38	5.03	0.36	2.84	0.29	1.89	1.76	3.33	11.12	9.97	5.02	30.35
1873....	3.58	1.44	2.07	5.29	4.45	6.89	6.18	0.04	2.28	2.62	1.39	4.43	6.78	11.81	13.11	6.39	40.76
1874 ...	2.47	2.23	3.75	2.80	3.48	2.00	5.30	4.01	2.33	0.84	2.37	1.45	9.13	10.03	11.31	5.54	33.03
1875....	0.54	2.61	3.28	2.80	4.55	10.09	10.00	2.54	0.33	1.30	0.91	2.25	4.60	10.63	22.63	2.54	41.23
1876 ..	4.44	2.91	6.79	2.11	2.84	5.76	5.78	5.55	7.32	*2.60	11.55	1.19	9.64	11.74	17.09	21.47	58.84
1877 ...	1.41	0.63	4.07	2.43	2.59	8.50	2.37	3.17	2.20	4.16	3.06	2.61	3.23	9.09	14.04	9.42	37.20
1878...	2.44	1.85	2.50	6.17	4.88	1.88	2.59	5.79	3.61	3.07	0.20	3.03	5.48	13.55	10.26	6.88	38.01
1879 ...	1.65	1.38	1.81	2.62	0.96	3.83	1.85	2.23	1.34	0.43	4.05	3.15	6.06	5.39	7.91	5.82	25.30
1880 ...	3.27	2.60	3.10	3.22	2.70	1.13	....	....	....	....	....	....	9.02	...	...	....	..
1881 ...	0.39	5.41	2.06	2.73	4.34	....	...	....	....	....	....	....	....	....	....	....	....
Average 12 years	2.19	2.54	3.60	3.72	4.60	5.22	4.14	4,07	2.90	2.96	2.89	2,86	7.59	11.92	13.43	8.98	41.92

1880 and 1881 not included.

Stations having a Record for 10 Years ending Dec. 31, 1887.

Cairo, Ills. Signal Service Record.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878 ..	3.05	1.94	2.97	5.61	4.41	4.61	2.81	3.45	2.99	2.59	3.80	3.53	41.76
1879 ..	2.81	2.03	2.95	2.93	2.79	8.70	1.37	7.05	0.93	3.87	3.25	6.63	45.31
1880 ...	4.56	5.01	4.52	3.25	4.64	2.92	4.34	2.61	4.55	6.96	3.98	2.22	49.56
1881 ...	3.56	4.97	1.33	3.62	2.44	1.81	0.18	0.11	2.74	2.74	4.98	3.70	32.18
1882 ..	6.35	10.14	4.22	4.14	10.22	3.34	5.25	3.46	3.28	2.57	5.96	2.65	61.58
1883 ..	2.74	8.52	2.15	5.64	3.85	6.11	7.95	1.73	0.34	6.97	4.36	2.18	52.54
1884 ...	2.32	5.58	4.20	3.65	4.57	2.95	7.34	2.74	5.02	1.89	2.41	8.99	51.66
1885 ..	3.49	1.48	1.08	1.43	3.21	4.63	0.82	2.40	4.76	2.89	2.79	3.01	31.99
1886 ..	3.82	2.54	2.84	6.64	2.98	4.87	1.01	2.84	2.52	0.45	5.73	1.74	37.98
1887....	2.15	4.60	2.18	2.09	1.37	2.34	1.42	1.10	1.67	0.38	3.33	4.12	26.75
Average	3.48	4.68	2.84	3.90	4.05	4.23	3.25	2.75	2.88	3.13	4.06	3.88	43.13

Carthage, Jasper Co., Mo.

Date.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.20	2.99	2.03	5.29	6.47	4.00*	4.61	0.52	3.15	2.10	1.00	1.96	36.66
1879	1.18	1.55	1.00	1.76	3.31	5.00*	2.00*	4.00*	1.27	1.85	3.44	2.35	28.71
1880	0.85	2.00*	1.82	4.45	1.50	2.50*	4.11	4.11	5.00	1.84	1.09	1.57	31.20
1881	1.44	3.15	2.43	1.61	3.76	5.00*	1.50*	1.43	3.95	8.55	4.36	2.05	39.23
1882	1.50	5.12	3.75	3.63	3.27	4.56	5.40	1.28	3.26	5.93	2.60	0.89	41.19
1883	1.38	4.78	0.87	1.47	5.10	5.15	12.18	6.42	0.40	11.76	2.01	2.14	53.67
1884	1.60	3.72	1.20	4.40	3.32	3.73	5.28	1.95	3.38	3.67	1.65	6.91	40.84
1885	2.30	1.15	1.66	7.54	4.40	5.36	4.31	1.30	4.73	1.09	0.84	1.69	39.37
1886	2.30	4.59	1.60	1.54	1.12	5.60	10.38	3.82	3.89	0.88	1.74	0.90	35.36
1887	0.70	3.16	2.62	2.08	6.06	7.23	2.32	6.14	2.71	3.40	1.57	2.08	40.07
Average.	1.55	2.92	1.90	3.38	4.13	4.81	5.21	3.43	3.21	1.11	2.03	2.25	38.93

* Approximated.

Centreville, Reynolds County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.00*	1.50*	4.00*	6.57	4.87	2.20	7.95	4.85	3.21	2.63	2.13	3.70	45.61
1879	1.88	1.60	0.92	1.43	2.21	7.91	3.50	10.27	1.44	1.78	6.82	3.01	42.77
1880	3.57	4.21	6.11	3.29	2.23	5.32	4.15	0.98	4.25	2.78	5.07	1.97	43.93
1881	1.00	5.22	3.82	2.08	4.42	5.17	0.75	0.71	2.11	4.77	1.95	2.15	37.15
1882	2.69	6.44	2.91	1.18	8.06	2.94	7.87	3.83	1.94	1.12	1.96	2.13	49.07
1883	2.23	6.95	1.62	4.25	6.15	6.10	5.77	5.84	0.64	7.50	5.55	1.82	55.02
1884	1.61	6.21	2.48	2.90	1.06	5.00*	7.00*	1.06	1.43	0.13	1.30	7.22	37.70
1885	2.14	0.85	1.49	2.00	3.20*	10.73	5.53	1.61	6.26	1.71	2.72	2.85	41.09
1886	2.10	2.11	3.87	4.26	2.89	5.31	0.05	5.22	4.73	0.96	5.83	2.12	39.75
1887	1.98	5.32	1.90	1.56	5.67	2.70*	3.80*	3.00*	1.30*	4.00*	3.50*	2.70*	34.43
Mean	2.12	4.04	2.91	2.95	4.11	5.37	4.64	3.74	2.73	2.77	4.28	3.00	42.65

* Approximated.

Chamois, Osage County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	*2.00	*2.50	*4.00	*6.30	*4.70	*2.20	*4.00	*3.20	*2.30	*1.50	*1.00	*3.27	36.97
1879	1.80	1.11	1.73	3.24	1.85	6.87	2.59	0.49	5.20	2.75	3.27	2.43	33.33
1880	1.01	1.79	0.81	3.56	3.27	2.12	1.71	0.98	0.99	1.75	1.29	1.80	21.08
1881	0.09	4.31	2.51	2.22	3.59	3.86	0.24	*0.25	8.93	5.03	7.34	1.52	40.89
1882	1.92	8.98	1.98	3.96	7.33	3.18	2.55	1.21	3.00	4.03	8.38	2.00	43.52
1883	1.24	5.32	2.50	1.29	3.58	5.34	2.76	0.63	0.35	8.70	4.00	1.61	37.32
1884 ...	0.88	5.12	4.34	3.51	2.30	3.94	4.30	3.30	5.62	1.84	2.60	4.37	42.12
1885 ..	2.95	0.75	0.51	4.49	3.36	7.94	5.93	5.13	7.74	1.55	0.60	1.86	42.81
1886	3.03	0.74	1.23	2.62	6.23	7.66	*	2.12	3.46	1.00	3.00	0.75	31.84
1887	*1.50	*3.00	*2.30	*3.50	*4.50	*2.70	*3.00	†2.90	*4.00	*1.00	*2.20	*2.80	33.40
Average	1.64	3.36	2.19	3.47	4.07	4.58	2.71	2.02	4.16	2.92	2.97	2.24	36.33

* Approximated.

Glasgow, Howard County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.35	3.37	4.35	2.72	3.73	0.96	2.78	1.30	2.02	1.66	0.50	3.82	28.56
1879	0.99	0.47	0.51	1.64	1.69	7.74	3.89	0.23	3.31	1.69	2.25	1.68	26.09
1880 ..	0.91	1.83	1.29	1.07	6.00	1.12	3.81	3.95	5.25	1.50	1.67	1.26	29.66
1881	0.01	5.45	3.39	2.06	4.56	6.18	2.33	*0.75	4.05	5.60	2.25	1.80	38.43
1882	1.26	3.38	*2.75	2.65	4.03	*5.25	4.30	1.53	4.24	4.78	4.13	1.27	39.57
1883	1.53	4.00	1.68	1.30	5.59	11.00	3.23	0.50	0.39	7.93	1.50	1.22	39.89
1884	1.25	2.23	2.36	3.03	3.29	3.28	10.95	2.98	8.64	4.85	2.27	3.37	48.50
1885	2.16	0.94	0.34	5.31	2.00	6.50	3.36	6.00	5.96	3.47	1.15	1.23	38.42
1886	2.00	1.29	2.06	3.35	1.69	*7.00	*0.40	*3.00	*4.80	*2.00	*1.70	*0.40	29.69
1887	*2.00	*3.00	*1.50	*3.30	*2.70	*6.00	*3.00	*1.70	*5.20	*1.90	*1.50	3.70	35.50
Average	1.35	2.60	2.02	2.64	3.53	5.50	3.81	2.19	4.39	3.54	1.89	1.97	35.43

* Approximated.

Glasgow, Morrison Observatory, Howard County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.12	3.13	4.38	2.71	3.99	2.79	0.83	1.39	1.95	1.76	0.46	4.20	28.71
1879	0.75	0.12	0.43	1.52	1.57	7.59	3.36	0.47	3.28	1.45	1.29	1.82	23.65
1880	0.67	1.67	1.24	0.99	5.76	1.06	3.78	6.08	2.67	1.50	1.59	0.68	27.69
1881	0.00	4.51	3.24	2.29	4.73	5.46	1.74	1.55	3.66	4.88	1.29	1.68	35.03
1882	0.78	3.05	2.68	2.45	3.91	4.77	4.60	1.71	4.06	4.19	3.96	1.14	37.33
1883	1.41	3.47	1.44	1.07	5.77	8.04	3.35	0.37	0.49	7.58	1.28	0.94	35.21
1884	1.17	2.01	2.30	3.40	3.30	3.02	12.16	2.76	8.38	4.53	1.98	2.95	47.96
1885	1.84	0.65	0.00	6.48	2.23	6.58	3.16	3.56	6.12	3.63	1.23	1.42	36.90
1886	2.16	0.90	2.11	4.02	1.77	5.30	0.40	2.69	4.85	2.22	0.92	0.41	27.75
1887	1.30	2.46	0.96	3.34	2.65	5.33	1.69	1.75	4.72	1.42	1.06	3.72	30.40
Mean	1.12	2.20	1.88	2.83	3.57	4.99	3.51	2.23	4.02	3.32	1.54	1.90	33.06

Glasgow, Morrison Observatory, Howard County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.	Dec	Year.
1877	....	....		....	....	....	....	....	....	*4.87	2.51	3.21	

* Not considered in average.

Greenfield, Dade County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.20	2.10	2.50	5.30	7.00	3.90	3.20	2.50	1.40	1.80	1.20	2.40	34.50
1879	1.08	1.50	1.15	0.95	5.27	6.15	*2.00	2.85	0.70	1.05	1.35	2.05	26.10
1880	0.45	1.25	0.85	4.10	4.70	1.85	4.90	5.80	1.95	1.70	1.25	1.00	29.80
1881	1.70	1.80	2.10	0.65	3.30	4.00	1.70	2.55	4.80	8.30	3.10	*1.70	36.00
1882	1.60	5.55	2.70	2.59	3.10	2.00	3.60	0.10	6.00	2.80	2.50	0.97	33.51
1883	0.30	2.90	0.60	1.05	2.60	*6.50	9.00	1.70	0.00	5.20	1.20	1.40	32.45
1884	0.60	1.10	1.30	6.50	2.50	1.90	6.60	0.50	4.00	2.50	2.10	3.80	33.40
1885	0.90	0.60	0.50	4.50	5.20	4.60	8.00	7.00	7.60	2.10	0.60	1.00	42.60
1886	1.60	0.80	1.40	1.20	5.50	6.30	4.50	3.70	4.70	1.10	1.40	1.50	33.70
1887	*1.00	3.00	*1.80	*4.00	*3.00	*6.20	*2.70	*3.50	*3.50	*2.50	*2.00	*2.20	35.40
Average	1.04	2.06	1.49	3.08	4.22	4.34	4.62	3.02	3.47	2.91	1.70	1.80	33.75

* Approximated.

Ironton, Iron County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.75	0.97	3.83	5.90	5.98	2.26	3.82	2.85	3.15	3.90	1.69	4.05	41.15
1879	1.60	1.63	0.97	1.43	1.35	6.73	3.47	8.30	2.02	2.82	8.72	3.81	42.88
1880	5.30	5.45	5.97	4.32	4.72	3.75	4.72	1.80	4.18	2.80	5.02	2.50	50.53
1881	1.17	5.69	2.25	3.30	3.95	7.00	0.95	4.25	3.55	4.30	5.90	2.35	44.66
1882	3.45	5.80	2.80	2.45	9.55	3.95	3.55	1.99	2.55	3.60	4.35	2.50	46.51
1883	2.60	7.45	2.32	4.85	7.30	6.90	5.10	2.15	0.75	8.50	6.80	1.92	56.61
1884	1.85	5.80	3.00	*2.50	6.30	5.75	7.00	1.20	1.95	0.95	2.15	7.47	45.92
1885	3.10	0.65	1.55	2.95	3.25	9.15	4.45	3.30	4.55	3.60	3.00	3.60	43.15
1886	1.90	1.65	3.50	3.60	3.30	4.20	1.30	1.45	4.90	1.45	5.50	2.40	35.15
1887	2.10	3.75	2.40	2.05	5.60	2.60	4.15	2.61	1.10	0.70	3.55	2.70	33.31
Average	2.58	3.88	2.86	3.34	5.13	5.23	3.85	2.99	2.87	3.26	4.67	3.33	43.99

* Approximated.

Kansas City, Jackson County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.33	2.52	2.63	2.99	4.03	2.26	3.82	1.26	2.73	0.75	0.51	3.34	28.17
1879	0.10	0.36	1.19	3.89	1.70	8.50	4.11	0.49	3.18	4.06	4.97	2.18	34.73
1880	2.35	1.31	1.72	3.16	3.80	3.23	2.97	12.26	3.03	2.95	2.30	0.00	39.08
1881	0.00	4.11	2.32	1.86	2.86	5.22	2.21	2.59	6.15	4.59	3.23	1.02	36.16
1882	0.35	2.05	1.30	2.83	4.21	2.76	3.21	0.95	4.31	3.93	2.51	0.79	29.20
1883	0.85	3.44	1.08	1.50	6.47	10.95	6.93	1.28	0.82	7.78	2.04	0.81	43.95
1884	1.20	1.85	2.69	3.36	2.52	4.69	4.73	6.76	6.90	4.30	1.07	1.95	42.02
1885	1.41	0.96	0.42	6.80	2.82	7.72	4.37	8.14	8.99	4.17	2.93	0.79	49.52
1886	0.69	0.23	2.01	1.26	4.73	3.37	0.00	0.68	2.61	1.43	1.27	0.76	19.04
1887	0.88	2.14	1.71	1.88	2.29	6.17	1.87	6.54	5.35	2.95	1.06	2.55	35.39
Average	0.92	1.90	1.71	2.95	3.54	5.49	3.42	4.09	4.11	3.69	2.19	1.42	35.73

Keokuk, Iowa. Signal Service Record.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	0.17	2.95	3.78	2.31	3.47	3.93	2.37	5.27	1.36	2.31	1.93	1.95	31.80
1879	0.50	0.53	1.71	1.56	2.27	2.63	1.98	4.57	1.12	0.28	3.91	1.45	22.51
1880	3.91	1.91	1.83	4.79	5.92	3.06	2.25	3.81	3.21	2.02	1.13	0.67	34.54
1881	0.50	2.58	2.42	3.12	1.35	8.70	3.08	0.86	4.10	8.01	2.59	1.70	39.01
1882	1.07	1.54	3.30	3.22	7.11	9.45	4.23	3.09	1.52	2.71	2.25	1.75	41.24
1883	1.24	6.15	1.07	2.97	4.87	5.87	3.14	1.32	1.76	6.95	2.09	1.20	38.63
1884	0.85	1.88	3.37	1.31	3.16	4.03	2.30	2.74	4.25	3.35	1.72	3.91	32.87
1885	2.44	1.10	0.17	3.33	2.59	6.97	2.29	5.98	3.77	3.59	0.88	1.96	35.07
1886	2.08	1.40	2.25	1.62	4.49	2.86	0.65	5.90	3.95	2.38	1.15	1.03	29.76
1887	1.48	5.19	0.76	1.00	2.54	1.55	1.57	2.38	3.13	1.98	1.18	2.73	25.49
Average	1.42	2.53	2.07	2.52	3.78	4.90	2.39	3.59	2.82	3.36	1.88	1.83	33.09

Kirksville, Adair County, Mo.

Date.	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	0.20	1.98	3.00	2.82	4.83	0.42	1.26	4.18	1.33	1.41	1.20	2.30	24.93
1879	0.18	0.40	1.37	1.98	2.48	7.34	4.76	4.43	2.72	1.38	3.65	1.37	32.36
1880	3.77	1.70	3.02	1.50	2.57	1.34	2.82	4.10	1.77	1.67	2.03	0.57	26.86
1881	0.00	4.72	3.57	2.70	0.78	8.38	1.90	0.98	5.05	11.30	2.93	*1.50	43.81
1882	*0.50	*1.70	*3.00	5.13	4.63	12.61	5.95	4.07	1.85	2.10	2.31	1.58	45.43
1883	1.06	3.76	0.69	1.23	4.78	7.51	3.15	3.20	1.12	5.57	1.68	1.09	31.84
1884	0.50	1.33	1.87	2.29	4.25	3.02	4.24	4.54	4.83	3.96	1.08	2.53	34.44
1885	2.00	0.70	0.01	3.34	2.77	4.49	2.45	3.52	1.58	4.57	0.25	0.55	26.23
1886	1.77	0.67	1.08	0.98	4.95	1.73	0.00	2.90	4.10	2.80	1.00	0.22	22.20
1887	1.70	3.62	0.57	0.98	1.17	2.77	3.34	3.88	3.11	2.22	0.63	2.20	26.19
Average	1.20	2.06	1.82	2.29	3.32	4.96	2.99	3.58	2.75	3.70	1.68	1.39	31.73

* Approximated.

Lamar, Barton County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.10	2.22	3.88	4.76	6.61	3.09	4.47	2.21	1.40	0.88	0.59	3.09	34.33
1879	1.85	1.09	0.75	1.24	4.36	5.01	2.16	5.71	1.55	2.61	4.45	2.76	33.54
1880	0.30	2.12	1.57	5.07	5.93	*2.50	5.02	7.20	2.52	1.20	1.22	1.00	35.65
1881	1.20	4.48	2.45	0.69	3.62	3.57	1.40	1.76	5.90	4.77	3.64	*2.20	35.68
1882	2.13	7.97	2.31	3.78	5.51	4.49	5.15	1.75	5.00	4.85	2.60	0.95	46.49
1883	1.33	3.36	1.85	0.91	4.25	5.12	7.55	1.57	0.25	7.83	1.41	2.05	37.48
1884	0.69	*2.00	*1.50	4.49	2.93	1.46	*6.00	*1.70	*4.20	*2.50	*1.70	*5.00	34.17
1885	*1.00	*0.70	1.27	6.64	5.02	3.12	7.75	7.04	13.24	1.57	0.49	0.91	48.75
1886	2.91	1.22	1.94	1.78	3.59	4.73	2.19	4.37	5.96	2.29	1.68	0.82	33.48
1887	0.63	1.78	2.63	4.78	2.74	6.90	2.87	3.85	4.01	1.94	1.50	2.09	35.72
Average	1.31	2.69	2.02	3.41	4.46	4.00	4.46	3.72	4.40	3.04	1.93	2.09	37.53

* Approximated.

Leavenworth, Kas.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.34	2.94	2.35	2.86	5.28	5.27	3.08	3.31	2.64	1.16	1.76	2.16	35.15
1879	1.16	0.54	0.32	0.42	3.04	9.90	4.99	0.18	3.41	4.25	7.85	2.34	38.40
1880	2.00	1.40	2.22	1.38	5.01	1.69	6.86	7.06	2.78	3.69	2.40	0.40	36.89
1881	0.44	4.84	2.21	1.86	3.65	5.27	1.72	2.74	6.89	5.73	3.42	1.18	39.95
1882	0.83	1.17	1.15	4.15	2.53	5.06	3.44	0.83	0.95	2.86	1.87	1.13	25.97
1883	0.75	2.92	1.05	0.97	7.33	10.84	3.58	1.95	1.57	8.31	2.02	0.65	11.94
1884	0.97	1.42	3.70	4.74	4.79	3.33	9.13	4.65	5.38	3.11	1.42	1.48	44.72
1885	1.47	0.87	0.31	6.63	5.89	4.00	4.56	5.20	7.65	4.23	1.86	0.97	43.64
1886	1.60	0.61	1.35	1.47	4.71	4.93	0.55	0.73	2.75	1.80	1.10	0.65	22.25
1887	1.27	1.94	1.59	1.99	3.07	5.43	1.36	7.11	5.73	3.87	1.11	2.55	37.05
Average	1.28	1.87	1.62	2.65	4.53	5.57	3.96	3.38	3.98	3.93	2.48	1.35	36.60

Lexington, Lafayette County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1878	1.34	3.57	2.58	3.42	3.26	2.77	4.60	1.20	1.78	1.58	0.50	4.00	28.60
1879	1.05	0.48	1.07	1.94	2.65	10.53	6.89	0.44	3.02	3.12	3.94	2.63	37.76
1880	2.29	1.62	1.85	3.63	3.63	0.65	3.70	5.14	4.37	2.24	2.51	0.97	32.60
1881	0.34	4.29	2.67	2.12	3.99	5.94	2.10	2.24	6.43	5.09	2.03	2.38	39.62
1882	0.99	2.50	1.75	3.87	4.72	5.76	4.83	2.71	3.38	3.94	4.10	1.35	39.90
1883	1.75	3.74	1.40	0.68	6.23	10.72	6.86	2.87	1.25	5.42	1.56	0.88	43.36
1884	1.70	1.51	1.94	2.87	4.22	1.85	7.26	3.95	6.84	4.50	1.51	2.45	40.60
1885	1.87	1.39	0.42	5.90	4.67	8.73	5.72	5.06	6.51	2.71	1.37	1.15	45.50
1886	1.79	1.08	1.15	2.74	3.59	4.66	0.31	1.19	3.36	1.72	1.63	0.51	23.73
1887	1.68	2.46	1.09	2.44	2.24	4.99	3.17	4.80	5.38	2.32	0.95	4.26	35.78
Average	1.48	2.26	1.59	2.96	3.92	5.66	4.34	2.96	4.23	3.26	2.01	2.06	36.77

Louisiana, Pike County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.32	3.15	4.52	3.04	6.01	1.05	3.40	1.65	1.00	2.15	1.40	2.55	31.24
1879	0.95	0.30	1.18	3.40	0.92	1.70	2.10	2.15	1.65	2.05	3.20	1.60	21.50
1880	0.80	1.45	1.72	1.24	6.37	*3.00	1.10	2.85	1.45	0.90	1.90	1.10	24.18
1881	0.00	3.70	3.95	1.10	1.37	7.40	1.00	0.00	3.65	8.95	3.95	3.10	38.47
1882	1.65	6.55	3.27	2.82	4.05	7.42	1.80	2.17	1.55	4.72	2.87	2.15	41.02
1883	1.65	5.75	1.35	1.60	4.27	9.75	2.75	1.35	0.19	3.92	1.82	0.61	35.01
1884	1.06	3.70	2.35	1.07	3.36	4.86	5.28	3.55	7.60	1.82	1.30	3.20	39.15
1885	2.88	1.00	0.10	6.00	2.95	4.39.	1.75	*5.00	*4.70	*3.00	*1.50	*1.30	34.57
1886	*3.00	0.59	1.72	2.51	2.72	4.78	0.01	5.12	8.46	0.65	1.91	1.45	32.92
1887	1.41	2.97	1.45	2.70	3.15	1.97	1.37	1.28	3.17	0.11	2.15	3.62	25.65
Average	1.47	2.92	2.16	2.55	3.52	4.63	2.06	2.54	3.34	2.86	2.20	2.13	32.37

* Approximated.

Mascoutah, St. Clair County, Ills.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.47	1.83	2.61	4.67	5.18	1.26	3.49	1.62	2.98	3.36	0.71	4.00	31.18
1879	1.24	1.64	2.62	1.00	1.08	5.31	1.05	2.72	1.35	1.31	6.10	3.06	31.48
1880	2.81	3.45	4.25	3.91	5.16	2.23	2.61	0.85	1.99	2.16	3.32	2.00	35.04
1881	0.27	4.72	2.18	2.09	2.63	2.39	4.61	0.54	1.65	6.01	6.65	1.55	32.35
1882	2.87	6.54	3.29	2.16	4.29	4.91	1.84	2.67	2.73	3.55	3.01	1.84	42.76
1883	0.95	6.32	2.67	3.40	3.18	6.69	3.97	2.36	0.03	7.81	3.53	2.18	43.09
1884	1.12	4.88	3.48	2.89	4.03	5.50	2.15	2.56	4.41	1.91	2.40	5.38	40.71
1885	2.66	1.28	0.56	3.83	3.53	3.87	3.01	4.35	5.46	5.93	3.01	3.82	41.34
1886	1.94	1.30	3.21	3.99	5.81	5.00	0.37	2.66	7.25	0.76	3.27	2.53	38.09
1887	0.96	3.90	5.03	3.29	3.91	1.96	2.27	2.51	2.67	1.11	6.34	3.50	37.15
Average	1.73	3.59	2.99	3.12	3.88	3.91	3.84	2.28	3.06	3.42	2.81	2.99	37.65

Mexico, Audrain Co., Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.94	3.18	3.94	3.82	4.47	3.46	1.40	5.58	1.08	2.46	1.26	3.28	35.87
1879	1.30	0.63	1.31	2.67	1.64	6.01	4.04	0.58	2.45	0.88	5.83	1.61	28.95
1880	1.23	1.64	1.32	1.89	6.35	3.00	4.87	3.21	1.95	1.10	1.97	1.36	29.89
1881	0.26	4.53	4.18	1.83	2.27	4.83	2.93	0.09	6.32	5.39	3.79	3.72	40.14
1882	1.43	6.32	2.37	1.72	5.32	5.04	5.27	4.27	2.62	3.26	3.26	2.11	46.09
1883	1.34	4.90	1.51	2.29	4.06	6.59	3.52	0.19	0.31	4.91	2.67	1.51	33.80
1884	2.37	3.29	1.37	2.99	2.62	2.42	6.75	2.33	8.21	1.72	2.60	4.01	42.68
1885	2.91	0.66	0.38	5.20	2.75	6.67	2.67	5.02	7.51	2.10	1.63	2.30	39.80
1886	2.51	0.74	1.31	3.08	2.88	5.66	0.03	2.53	4.77	1.27	1.99	0.88	27.65
1887	1.38	2.86	1.45	3.30	4.60	2.06	0.73	0.39	3.69	0.73	1.82	4.02	27.01
Average	1.57	2.88	2.21	3.18	3.70	4.57	3.22	2.42	3.89	2.39	2.68	2.48	35.19

Miami, Saline County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.22	3.53	3.89	3.19	5.69	1.85	4.38	2.68	2.10	1.63	0.54	3.50	34.20
1879	0.60	0.43	0.73	2.90	2.09	11.11	5.64	2.81	3.87	2.55	2.54	2.25	37.55
1880	1.76	1.66	1.76	1.52	6.10	1.07	2.21	4.38	4.64	2.63	2.22	1.18	31.13
1881	0.36	4.52	2.63	2.48	*4.20	8.48	0.94	1.29	5.24	5.66	2.65	3.40	41.85
1882	0.92	2.83	2.95	1.60	4.50	4.20	3.91	3.36	3.83	3.54	*3.00	*1.50	39.14
1883	*1.70	*3.80	*1.30	1.52	6.29	11.45	6.88	0.59	*0.80	6.47	1.96	*1.00	43.76
1884	1.52	1.62	2.30	3.99	3.70	4.84	14.17	6.52	6.59	5.09	1.64	3.68	55.68
1885	2.76	1.28	0.45	7.25	2.68	6.36	3.90	6.43	5.39	4.88	1.93	2.06	45.37
1886	3.05	2.17	1.63	3.43	3.50	7.39	0.20	3.79	4.51	1.73	1.79	*0.70	33.87
1887	1.57	3.29	1.35	2.78	1.95	7.88	3.92	2.44	6.48	2.50	1.46	3.06	38.68
Average	1.55	2.51	1.90	3.37	4.07	6.46	4.62	3.43	4.34	3.67	1.97	2.23	40.12

* Approximated.

Mine La Motte, Madison County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1877....	....	....	....	....	....	4.44	0.75	5.19	5.06	3.44	4.25	2.25	....
1878....	3.81	1.94	3.25	7.63	5.06	3.88	3.50	3.69	3.81	2.69	1.25	3.50	44.01
1879....	1.56	1.31	2 31	1.38	2 31	6.19	2.75	9.06	2.06	1.63	6.56	4.38	41.50
1880....	5.00	4 69	4.56	3.31	5.25	4.69	5.69	3.50	4.44	2.19	4.00	1 94	49.26
1881....	1.44	4.94	2.19	3.56	4.25	5.69	0.94	2.44	1.56	4.38	5.81	2.75	39 95
1882....	3.19	7.00	3 06	1.81	6.75	3.00	5 75	4.25	2.75	3.56	5.50	1.88	48.50
1883....	2.31	8.06	2.25	4.69	5.31	8.19	5.94	4.25	0.38	8.63	7.19	2.06	59.26
1884....	1.38	5.38	2.75	2.75	6.38	4.38	6.44	1.19	2.88	1.69	1.94	6.13	43.29
1885...	2.75	0.88	1.63	3.38	2.68	8.06	5.88	3.13	3 19	1.81	2.94	2.56	38.89
1886....	2.38	2.38	3.00	4.56	4.25	6.06	2.31	1.81	6.13	1.25	5.13	2.56	41.82
1887....	1.44	4.06	2.81	1.94	4.94	1.69	4.31	2.81	1.81	0.88	3 56	3.44	33.69
Means..	2.53	4 07	2.78	3.50	4.72	5.18	4.35	3 61	2.90	2.87	4.39	3.12	44.02

Pierce City, Lawrence County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878....	*2.20	*3.00	*3.00	*5.00	*6.00	*6.00	3.70	0.40	3.30	1.90	1.30	1.30	37.10
1879....	1.50	5.90	0.60	2.70	4.80	4 40	3.10	2.20	1.00	1.60	6 00	2.80	36.60
1880....	2.60	4.20	2.80	6.80	4.60	3 60	5 50	7.10	1.40	5.10	1.60	2.40	47.70
1881 ...	1 30	5.10	3.10	1.80	6.70	5.10	2.00	2 60	5.40	8.10	3.70	1.70	46.60
1882....	2.30	5.20	4.00	3.80	5.30	3 40	8.20	0.00	2.30	9.50	5.60	1.00	50.60
1883....	1.00	7.65	1.90	2.70	4.40	6 00	9.30	4.80	0.20	8.90	2.80	2.30	51.95
1884....	0.90	4.70	1.30	5.60	4.10	4.20	5.10	3.70	7.30	*2.00	2.90	10.10	51.90
1885....	1.20	0.90	1.90	6 80	5.50	5.10	8.70	7.20	6.90	1.40	2.40	1.00	49.00
1886....	2.10	1.80	3.30	2.50	2.20	7.40	8.40	3.10	4.30	2.50	1.80	*1.50	40.90
1887....	*2.20	*3.70	3.65	2.70	3 30	*5.70	*2.70	*6.00	*1.70	5.10	3.80	1.70	44.65
Means..	1.73	4.21	2.56	4.04	4.69	5.09	5.67	3.71	3 38	4 61	3 19	2.82	45.70

* Approximated.

Pleasant Hill, Cass County, Mo.

Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878....	0.78	1.95	2.09	2.69	4.72	4.31	3.20	1.80	1.85	1.27	0.62	3.98	29.26
1879....	0.81	0.40	0.55	2.11	1.67	6.35	*6.00	0.20	1.31	*4.20	*4.30	*2.40	30.30
1880....	2.20	1.50	1.80	2.02	3.50	2.35	3.50	5.50	1.54	1.95	2.51	0.40	28.77
1881....	0.15	4.65	2.55	*1.50	*4.00	*5.00	*1.60	*3.00	*6.00	*6.00	*1.80	*2.20	38.45
1882....	1.00	2.85	2.50	2.98	4.83	3.82	1.31	0.95	1.85	4.26	2.67	1.15	30.17
1883....	1.35	3.85	1.80	2.02	6.05	8.90	7.05	3.73	2.00	8.13	*1.90	1.32	48.10
1884....	*1.60	*1.70	*2.30	*5.00	0.91	4.50	4.40	4.30	10.30	4.15	*1.80	1.92	42.88
1885....	1.30	*1.40	0.50	10.05	2.49	4.55	*5.00	2.00	4.80	2.20	1.00	1.25	36.54
1886....	1.95	0.94	1.24	2.16	6.65	2.40	0.00	1.05	2.40	1.50	2.46	1.20	23.95
1887....	1.15	3.65	1.35	3.70	2.15	6.55	2.46	3.00	*3.60	*2.00	*1.40	*3.00	34.01
Average	1.23	2.29	1.67	3.42	3.70	4.87	3.45	2.55	3.56	3.57	2.05	1.88	34.24

* Approximated.

Savannah, Andrew County, Mo.

Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878....	*1.20	*1.00	*2.80	*2.40	*4.50	*4.00	*6.20	*1.50	*3.20	*2.00	*0.70	*2.20	31.70
1879....	*1.00	*0.40	*0.40	*3.00	*2.30	*7.00	*6.60	*1.00	*3.00	*2.50	8.90	1.65	37.75
1880....	1.52	0.80	1.35	2.85	4.90	3.28	3.52	6.81	2.67	2.16	1.15	1.06	32.67
1881....	0.57	4.22	1.86	3.11	4.80	7.14	1.70	2.42	3.31	7.75	3.20	1.13	41.21
1882....	1.00	1.32	1.87	5.90	*3.60	*5.00	*1.10	*0.80	*0.70	*4.30	*1.70	*1.60	28.89
1883....	*1.50	*3.40	0.45	2.75	6.50	9.32	*2.00	*1.00	*1.70	*6.50	*1.00	*0.80	36.92
1884....	1.10	1.02	1.85	2.70	3.55	*5.00	4.90	*4.00	*4.20	3.95	1.50	2.20	35.97
1885....	*1.70	1.15	*0.40	4.30	2.55	3.90	4.55	0.75	3.45	5.35	1.00	0.90	30.00
1886....	2.12	0.40	2.22	2.10	1.80	2.60	0.30	2.22	3.10	3.95	0.90	0.45	22.16
1887....	0.85	3.25	1.50	*2.00	*3.00	*3.20	*1.60	*5.20	5.25	2.80	*1.00	1.60	31.25
Average	1.26	1.70	1.47	3.11	3.75	5.04	3.25	2.57	3.06	4.13	2.10	1.36	32.79

* Approximated.

Sedalia, Pettis County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yea.
1878	1.52	3.07	2.91	3.02	3.16	2.86	3.15	2.81	1.49	0.51	0.67	4.53	29.70
1879	1.47	0.65	0.13	4.33	0.97	8.18	4.19	0.60	3.77	2.01	2.75	1.32	30.97
1880	0.88	1.81	1.02	2.36	5·03	2.11	1.75	2.52	*2.00	1.72	1.16	0.62	23.28
1881	0.19	3.18	3.27	1.40	4.30	2.96	1.62	1.27	7.12	5.28	3.17	2.09	36.15
1882	1.44	1.95	2.01	2.26	4.68	4.15	5.46	1.62	1.81	4.99	2.56	1.06	36.99
1883	*1.40	4.14	2.55	1.85	5.66	7.63	7.83	0.90	*0.40	7.07	1.56	1.01	42.30
1884	3.53	*3.00	3.20	*3.30	*3.00	*4.30	6.93	2.22	10.54	2.81	2.24	1.77	49.84
1885	4.01	1.34	0.65	5.09	5.39	8.92	5.07	2.61	7.19	2.63	0.53	1.00	44.43
1886	1.00	1.12	1.65	4.37	6.51	8.41	0.62	1.12	4.38	2.40	2.81	0.53	35.22
1887	2.01	1.94	1.84	4.12	3.98	7.83	3.16	0.69	6.05	1.15	1.80	3.10	37.97
Average.	1.74	2.55	1.95	3.21	4.27	5.76	3.98	1.67	4.50	3.09	1.96	2.00	36.68

* Approximated.

Shelbina, Selby County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	*1.10	*3.90	*3.80	*2.10	*6.10	*2.00	*2.50	*3.30	*2.50	*2.00	*1.30	*1.50	32.10
1879	*0.70	*0.70	*1.00	*1.60	*1.20	*5.00	*3.50	*3.00	*2.50	*0.50	3.60	1.15	24.75
1880	1.90	1.75	1.45	0.81	5.00	1.82	3.56	2.10	1.20	2.40	2.11	0.76	25.16
1881	0.03	3.77	3.45	2.30	2.50	8.41	1.60	0.02	1.83	8.10	2.60	1.00	38.91
1882	1.20	2.21	3.11	5.00	4.00	7.20	3.00	0.50	2.60	1.96	2.90	2.40	39.08
1883	1.80	1.30	1.91	0.82	4.60	6.30	7.15	3.70	0.20	9.90	2.10	1.20	43.98
1884	0.70	2.50	2.40	1.10	3.10	4.00	5.80	4.70	6.30	2.10	0.18	4.20	37.38
1885	2.40	1.20	0.23	4.20	3.50	8.61	4.80	2.80	6.40	3.00	1.30	1.00	39.44
1886	2.90	1.21	2.90	*2.00	2.30	3.40	0.01	4.70	7.50	2.40	1.30	1.30	31.92
1887	2.20	2.57	1.00	2.20	3.70	1.43	4.20	1.51	5.40	1.50	1.30	3.30	30.31
Average.	1.49	2.41	2.13	2.21	3.63	4.82	3.61	2.66	3.91	3.72	1.87	1.81	34.30

* Approximated.

St. Charles, St. Charles County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.	Dec.	Year.
1878	1.85	1.58	3.15	4.45	1.94	1.51	0.70	1.41	3.35	1.90	4.10	2.87	29.44
1879	1.78	1.24	2.31	2.85	0.81	2.90	4.13	4.55	1.24	3.10	4.02	2.90	30.86
1880	1.37	2.65	1.95	2.63	3.20	4.15	5.40	1.60	1.12	2.40	3.10	2.40	31.67
1881	0.25	4.70	2.20	2.00	5.90	3.22	0.90	0.60	4.25	6.40	6.60	0.80	37.82
1882	2.15	8.01	2.55	2.50	4.60	4.80	3.30	2.40	1.20	3.20	3.20	1.25	39.16
1883	0.90	7.10	2.20	2.00	2.60	5.60	3.10	1.90	0.00	5.41	3.95	1.46	36.22
1884	1.45	4.80	4.25	4.10	2.45	6.55	4.70	1.40	4.25	2.00	1.65	3.70	41.30
1885	2.75	0.80	0.50	4.60	2.10	7.90	3.30	5.70	4.50	2.85	1.80	2.00	38.80
1886	3.50	1.50	2.80	1.45	4.05	5.50	0.50	2.60	5.10	0.70	3.80	4.00	32.50
1887	0.95	4.15	2.80	3.94	5.75	1.35	2.15	2.40	2.50	1.00	4.00	2.60	33.59
Average.	1.69	3.65	2.50	3.05	3.64	4.35	2.82	2.76	2.75	2.77	3.32	2.40	35.40

Washington University, St. Louis, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.80	1.71	2.94	6.31	4.70	2.44	2.87	5.06	3.93	3.32	1.02	3.56	40.66
1879	1.86	1.66	1.70	2.69	0.90	3.86	2.16	2.12	1.45	0.57	4.22	2.77	25.96
1880	3.94	3.13	3.10	3.44	3 21	2.50	5.37	2.00	3.45	2.08	3.24	1.64	37.10
1881	0.39	4.74	2.47	3.01	1.00	3.23	2.35	0.27	2.80	7.60	6.32	4.50	38.68
1882	3.68	7.21	3.39	4.30	4.36	4.78	3.56	2.53	1.46	2.33	3.16	1.75	42.51
1883	1.03	6.27	2.21	2.62	2.61	4.73	4.11	2.24	0.00	6.00	2.18	1.42	35.42
1884	2.08	3.88	3.63	3.92	2.49	4.01	2.94	1.39	6.06	1.86	2.19	6.63	41.08
1885	3.56	1.00	0.49	4.28	2.50	6.30	1.28	2.74	8.62	7.02	1.80	2.01	41.60
1886	3.51	1.63	3.30	2.50	7.93	7.26	0.24	2.60	9.57	0.95	3.87	3.04	46.40
1887	0.70	3.78	3.87	5.50	5.46	2.29	2.70	1.04	2.60	0.60	1.79	3.24	36.54
Average.	2.36	3.50	2.71	3.86	3.82	4.14	2.76	2.20	3.99	3.23	3.28	2.76	38.60

Stations having a Record of less than Ten Years.

Station near Allenton, St. Louis Co., Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1864	.....	.....	.....	.....	.....	.....	0.14	1.66	3.37	2.13	3.90	1.63	.....
1865	0.65	4.27	8.87	3.89	4.63	4.57	9.26	.....	...	.....	.....	.....	.....
1866	.....	.	2.97	3.68	3.04	3.32	4.93	3.53	8.90	2.93	1.48	2.78	.....
1867	2.66	3.48	2.76	0.89	7.86	5.14	2.95	2.25	0.52	1.54	2.24	2.59	34.88
1868	1.69	0.82	8.87	6.05	5.71	1.67	2.30	5.54	7.19	1.90	2.01	3.22	46.97
1869	1.94	2.45	4.21	6.08	3.71	8.11	1.82	2.75	1.60	2.71	5.66	2.70	43.80
1870	2.31	0.59	4.95	2.60	2.57	4.88	3.67	5.99	0.99	4.13	2.16	2.85	37.69
1871	1.26	1.21	1.93	1.00	1.35	1.19	4.48						

Ashley, Pike County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	..	...	...	.....	.....	.....	.....	.....	1.33	2.15	1.21	3.01	.....
1879	1.41	0.73	2.18	4.24	3.69	3.16	3.99	1.76	2.55	2.74	4.47	2.26	33.18
1880	1.51	2.35	1.87	2.05	7.00	4.61	.....	.....	*2.01	1.35	2.09	1.79	.....
1881	0.31	3.62	3.67	1.73									

* Twenty-three days.

Big Creek,* Lincoln County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.70	3.10	3.70	4.66	4.28	1.05	1.12	5.86	1.71	0.86	0.60	3.27	31.91
1879	2.52	0.65	2.73	1.90	1.22	2.44	2.34	0.24	1.00	0.70	4.51	2.20	22.45
1880	1.13	1.75	0.92	2.02	4.90	2.90	3.64	3.76	2.23	1.32	1.67	1.56	27.80
1881	0.22	2.57	3.70	1.80	2.96	2.85	2.53	0.01	9.01	4.93	5.27	0.85	36.70
1882	2.65	6.46	2.16	3.45	4.65	4.18	4.17	2.10	2.95	3.20	1.50	2.05	39.82
1883	1.25	5.90	1.70	....	4.05	5.99	1.85						

* Near Troy, Mo.

Bolivar, Polk County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868	......	......	......	......	.....	......	......	......	.....	......	......	4.65	....
1869	4.50	0.95	4.90	3.65	3.40	3.70	3.10	2.81	1.20	0.12	6.50	4.30	39.13
1878	1.20	1.86	2.00	5.30	8.00	4.90	0.50	2.70	1.10	1.90	1.70	2.40	33.56
1879	0.50	1.40	1.30	2.50	3.20	5.10	2.20	2.50	0.50	3.60	3.20	3.60	29.60
1880	0.80	1.90	1.30	4.30	4.70	2.20	6.40	3.51	2.00	2.70	1.30	1.20	32.01
1881	0.40	4.30	1.90	2.10	4.40	6.10	1.60	2.20	4.20	7.40	1.60	1.30	40.50
1882	1.90	5.00	2.80	1.40	5.70	2.20	2.00	2.80	5.90	3.20	3.80	2.30	39.00
1883	0.60	5.00	2.00	1.20	4.03	6.40	5.50	*1.50	0.30	6.70	1.80	2.30	37.33
1884	0.70	2.50	2.50										

* Approximated.

Boonville, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	*1.50	*3.20	*4.00	*3.00	*4.00	2.51	2.34	2.11	1.13	1.57	0.43	3.81	29.60
1879	0.97	0.62	0.71	1.92	1.95	8.26	2.87	0.60	2.97	1.11	2.62	1.71	26.11
1880	0.88	2.00	3.24	2.63	5.88	3.45	4.31	2.00	3.76	1.40	1.13	1.25	32.23
1881	0.08	4.50	3.16	1.80	2.85	5.06	0.50	0.93	5.19	5.27	3.41	2.56	35.34
1882	1.55	4.99	2.30	4.03	5.74	5.20	3.48	2.23	2.30	6.00	2.31	1.55	41.68
1883	1.51	3.19	2.03	0.82	4.82	*8.50	2.49	0.79	0.25	6.47	1.93	1.14	33.94
1884	1.24	3.28	3.51	2.32	2.73	*4.00	6.31	3.48	10.69	*3.00	0.95	3.80	45.31

* Approximated.

Brunswick, Chariton County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1874	.....	......	......	......	......	......	2.24	2.14	4.77	1.63	2.09	0.30	......
1875	0.09	0.75	1.62	2.46	4.31	5.25	11.35	2.65	2.29	1.91	1.05	3.44	37.17
1876	1.20	0.49	3.41	6.48	3.47	9.45	6.49	5.04	5.25	1.05	1.34	0.05	43.72
1877	0.85	0.00	3.25	3.00	5.48	8.80	1.70	4.35	2.67	7.50	1.69	3.15	42.44
1878	1.25	3.80	4.35	3.83	7.70	2.95	5.34	3.50	2.20	2.10	0.60	1.61	39.23
1879	0.78	0.90	0.30	2.70	1.45	10.50	4.50	3.05	3.25	3.21	3.35	2.10	36.09
1880	1.90	1.80	1.70	0.95	8.25	1.45	2.15	8.00	4.17	2.90	2.40	0.43	36.10
1881	0.00	3.00	1.80	1.90	5.10	9.00	1.10	1.25	4.60	6.75	2.25	2.33	39.08
1882	0.25	1.13	1.44	3.39	3.37	4.45	2.68	3.49	0.75	3.60	3.06	0.80	28.41
1883	0.90	3.40	0.70	0.50									

Carrollton, Carroll County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1879	......	.....	......	......	......	......	......	1.10	1.30	5.45	3.75	6.70	....
1880	2.50	1.00	3.20	1.61	5.95	1.15	3.50	6.43	5.15	3.25	2.09	0.49	39.62
1881	0.00	1.26	4.55										

Cave Springs, Greene County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1871	1.65	2.74	3.19	3.13	......	......	.....	3.20	0.10	7.00	1.00	1.30	....
1872	1.00	......	......	......	......	......	.....	......	......	......	......	......	....
1873	......	......	......	......	.....	......	1.90	1.50	6.50	2.60	1.10	4.80	. .....
1874	2.82	2.20	2.90	6.60	3.10	1.70	1.50	2.70	4.10	1.20	7.00	1.30	37.12
1875	0.80	3.30	3.30										

Chillicothe, Livingston County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	0.57	2.69	2.39	2.18	......	2.32	7.57	3.50	......	......	......	... ..	....
1880	*2.00	*1.00	*3.00	*2.00	1.70	1.30	2.14	5.02	2.50	3.35	2.01	1.42	27.44
1881	2.34	5.96	2.59	4.49	5.91	9.17	1.20	*1.50	6.20	*6.50	2.60	1.55	49.95
1882	0.50	2.05	1.30	......	......	8.70							

* Approximated.

Clinton, Henry County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.50	1.95	2.15	6.64	7.20	3.71	3.90	2.10	*1.50	*0.50	*1.20	*3.60	35.95
1879	......	....	......	......	......	.....	......	......	......	......	2.50	1.20	......
1880	0.30	0.70	0.50	1.10	5.10	2.80	1.77	*4.00	*1.20	1.60	*1.00	0.40	20.47
1881	0.00	3.00	1.80	*1.00	*1.50	3.50	1.70	2.20	*6.00	*7.00	3.40	1.19	35.59
1882	1.79	4.67	2.15	2.58	6.69	2.85	4.73	2.83	0.86	7.63	2.50	*1.20	40.48
1883	1.60	1.54											

* Approximated.

Conception, Nodaway County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1883	......	......	......	......	......	......	......	......	......	......	1.21	0.13	......
1884	0.75	0.43	2.41	2.44	3.84	3.02	6.12	......	4.07	2.92	0.94	1.46	.....
1885	......	.....	0.10	4.93	1.96	9.25	1.75	1.85	2.47	4.83	0.60	1.30	......
1886	2.51	0.75	......	2.76	4.73	2.12	0.68	1.57	5.05	5.34	1.39	0.70	......
1887	5.06	2.79	3.54	1.50	4.00	4.69	1.27	3.87	5.18	2.25	0.67	0.73	35.55

Cuba, Crawford County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	*2.50	*2.00	*3.75	*6.50	*6.00	2.04	4.66	8.17	3.50	*2.00	1.43	2.29	41.84
1879	1.19	1.12	*1.50	*2.50	1.78	4.60	5.69	3.04	1.43	1.04	4.72	2.67	37.28
1880	2.74	3.02	*2.75	*5.50	3.67	3.81	3.20	0.50	0.68	2.58	2.88	3.00	34.33
1881	0.76	4.23	*1.25	*2.00	*5.00	7.10	0.93	0.05	*5.00	*5.25	*5.50	*0.75	37.82

* Approximated.

East Prairie, Mississippi County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868	3.37	1.00	5.27	6.15	0.95	1.31	3.65	4.90	4.30	2.00	1.75	5.60	40.25
1869	1.25	2.00	2.45	4.00	3.92	2.25	10.70	1.50	0.15	1.05	4.20	1.83	35.30
1870	2.45	3.30	2.71	2.90	1.90	2.41	5.90	4.35	0.95	1.35	2.40	2.25	32.87
1878	2.61	1.80	2.90	2.97	5.20	4.15	2.47	2.22	3.05	2.12	3.60	3.45	36.54
1879	3.01	2.00	2.71	3.40							5.00		

Edina, Knox County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1859	......	......	......	......	3.87	2.50	1.50	3.75	3.75	0.25	2.50	0.60	....
1860	0.80	1.40	0.25	0.12	0.62	5.50	1.37	3.25	2.88	0.75	0.06	3.88	20.88
1861	1.35	0.80	3.80	6.37	1.87	4.06	1.66	0.66	3.66	1.56	1.06	1.23	28.08
1862	3.75	0.10	1.23	4.50	2.04	5.66	1.68	3.00	4.25	2.37	1.12	4.45	34.45
1863	1.80	2.53	2.46	0.32	4.12	1.33	1.35	3.24	2.00	2.35	0.75	2.47	24.72
1864	1.18	0.50	0.79	5.78	1.33	2.06	3.00	1.00	3.75	1.88	2.45	2.70	26.42
1865	0.10	2.45	2.64	5.57	0.12	5.84	10.20	1.64	6.65	4.25	0.00	1.00	40.46
1866	3.18	1.34	4.95	4.00	1.56	4.12	5.75	0.45	10.12	1.12	1.50	2.85	40.94

Fayette, Howard County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1886	....	0.90	2.35	3.57	3.12	5.40	0.76	3.06	6.11	1.99	1.85	0.79	....
1887	1.10	2.92	1.21	3.62	4.55	3.30	1.37	0.49	3.73	1.57	1.76	3.42	29.04

Forsythe, Taney County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	......	......	......	......	......	......	......	......	......	1.80	0.60	3.00	......
1879	1.70	0.70	0.99	1.04	2.67	3.20	1.00	1.00	0.30	1.60	3.10	2.20	19.50
1880	0.40	0.60	4.10	*5.00	1.20	3.80	*4.50	5.00	*1.50	4.80	2.40	0.50	33.80
1881	1.89	4.60	1.10	1.90	2.90	*5.00	*1.00	*2.50	1.80	1.80	1.30	2.40	28.19
1882	3.40	......	......	......	.....	3.21	5.65	1.02					

* Approximated.

Gayoso, Pemiscot County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.60	3.00	3.10	4.00	3.80	5.20	5.60	1.10	3.60	2.30	3.80	2.90	11.30
1879	4.30	2.80	2.60	3.50	1.00	3.50	4.70	7.00	1.90	2.50	4.70	7.50	16.00
1880	6.50	7.70	3.60	5.00	2.60	2.80	1.00	2.10	4.80	3.50	3.80	3.40	19.80
1881	1.10	6.00	2.40	4.00	6.20	8.90	1.30	*2.50	*2.40	*2.50	*5.00	*2.50	17.80

Grant City, Worth County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	0.00	0.06	1.16	1.14	2.05	3.70	5.90	2.70	2.01	2.10	*0.70	*1.00	22.52
1879	0.50	0.20	0.40	2.30	2.05	......	......	1.80					
1881	......	......	......	1.30									

* Approximated.

Hamilton, Caldwell County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	0.60	2.80	2.48	1.27	2.59	1.80	2.94	2.96	2.87	0.66	0.53	2.36	23.86
1879	0.75	0.38	0.30	1.56	1.61	7.97	4.02	2.43	2.48	3.13	4.50	1.40	30.53
1880	1.80	0.75	2.65	2.25	3.37	1.84	2.05	4.77	2.70	3.00	2.00	0.70	27.88

Hannibal, Marion Co., Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1854	0.31	1.91	3.81	3.36	4.50	4.50	1.25	1.84	1.90	2.91	0.50	0.89	27.68
1855	......	0.56	2.00	0.94	7.00								
1878	......	......	....	......	......	......	......	......	1.23	2.37	0.62	2.30	......
1879	0.61	0.84	......	1.60	2.40	2.20	3.30	3.00	1.60	0.30	2.70	0.30	......
1880	1.40	1.80	1.00	1.20	4.70	2.10	1.00	1.20	0.70	1.20	1.10	0.95	18.35
1881	0.00	2.21	1.30	0.40	2.40	8.50	2.30	0.10	3.90	10.70	3.20	2.25	37.26
1882	*1.50	3.60	3.10	4.30	5.90	6.80	2.90	2.40	1.20	3.90	2.30	*2.00	39.90
1883	*1.50	3.20	1.80	1.40	4.50	9.70	5.40	1.60	1.10	8.00	1.70	1.30	41.20
1884	*0.80	4.71	4.30	1.90	3.40	1.17	2.16	3.23	*6.00	3.10	*1.60	*3.50	33.47
1885	3.60	1.00	*0.10	4.70	4.50	1.80	*2.00	2.50	1.45	3.60	0.80	1.00	33.05
1886	....	0.70	....	2.10									

* Approximated.

Harlem, Clay County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.20	2.20	3.50	2.55	2.60	0.79	1.80	1.72	2.70	1.00	0.50	1.50	25.06
1879	0.60	0.45	0.80										

Harrisonville, Cass County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1863	......	......	......	......	......	.....	......	......	......	0.31	......	.. ..	......
1864	......	.....	......	5.61	2.20	2.37	3.50	1.91	3.31	2.81	3.81	2.25	......
1865	0.15	3.40	3.44	7.41	4.64	12.16	10.66	6.45	8.09	0.74	0.04	1.02	58.50
1866	1.25	1.67	2.20	7.92	5.52	4.38	7.87	4.00	9.68	7.78	2.89	3.21	58.37
1867	1.31	6.56	1.90	4.94	10.64	2.58	2.40	2.80	5.23	1.71	0.86	0.99	41.92

(Continued.)

Harrisonville (continued).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868	0.50	0.48	......	2.51	4.23	3.73	1.54	8.96	6.63	2.53	6.20	4.86	......
1869	4.31	1.20	1.34	4.48	3.23	8.42	2.31	3.85	3.55	0.16	1.60	1.62	36.07
1870	0.50	......	0.97	0.63	2.76	2.00	2.09	7.43	4.11				
1878	......	......	......	......	......	3.93	2.58	3.00	1.51	0.42	0.69	3.95	......
1879	0.50	0.60	0.31	2.10	3.07	4.91	4.85	0.86	2.88	1.37	1.27	2.11	30.86
1880	1.15	1.25	0.87	2.05	2.60	2.18	3.52	5.27	1.26	2.09	1.57	0.41	24.25
1881	0.42	5.21	2.05	1.20	4.55	4.22	1.85	3.45	5.80	6.85	1.70	2.05	39.35
1882	1.19	1.42	3.50	2.92	5.02	3.78	2.09	0.95	2.01	3.51	1.99	1.24	29.62
1883	2.01	5.24	0.85	0.37	7.25	7.53	2.85	2.23	1.10	1.10	1.92	1.20	36.95
1884	1.60	1.78	2.30	5.53	0.75	2.45	2.42	2.30	9.18	1.43	1.87	3.74	38.35
1885	2.85	......	0.97										
1887	......	......	......	......	......	......	......	5.00	3.10	1.69	1.43	2.96	......

Hematite, Jefferson County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868	......	......	......	7.40	7.70	4.80	2.65	5.90	7.05	1.80	2.05	3.45	......
1869	1.40	2.10	5.90	2.80	3.95	5.45	1.55	7.10	2.40	2.40	5.20	2.25	45.50
1870	2.60	0.20	4.05	2.55	1.25	1.25	4.41	4.56	1.37	1.45	2.19	3.62	32.50
1871	4.31	3.63	2.01	0.77	4.48	1.67	4.76	1.21	0.48	2.62	1.68	1.20	28.82
1872	1.59	2.56	2.78										

Hermitage, Hickory County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1867	......	......	......	......	......	......	......	......	0.13	2.32	1.63	0.69	......
1868	0.63	0.15	......	4.93	1.29	1.47	1.09	5.54	6.12	1.17	3.35	3.12	......
1869	2.68	1.96	2.91	1.88	6.22	6.25	5.25	1.14	1.72	2.32	3.25	2.10	37.98

Hopkins, Nodaway County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	0.05	0.72	2.24	1.92	6.09	6.97	6.34	1.24	*2.00	*3.00	*0.70	*1.00	32.27

* Approximated.

Houstonia, Pettis County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1885	2.56	1.11	0.86	5.27	3.02	5.81	4.63	2.81	6.00	3.25	1.40	1.04	37.76
1886	1.70	0.88	1.46	6.42	5.15	1.24	0.06	1.60	4.09	1.34	1.46	0.54	28.94
1887	1.48	3.13	1.07	3.69	4.19	10.07	1.72	1.97	*6.00	*1.50	*1.80	*3.00	39.62

* Approximated.

Jackson, Cape Girardeau County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	3.85	1.51	2.73	6.50	4.99	2.84	3.55	*2.00	1.75	3.52	2.30	3.71	......
1879	1.94												

* Approximated.

Jefferson City, Cole County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1875	......	......	......	4.14	3.23	4.71	6.28	0.80	0.00	0.00	0.00	1.16	......
1876	*0.53	......	*0.62	*0.82	2.25	7.19	9.31	5.15	1.53	2.06	1.25	......	.....
1877	......	......	......	*3.73	5.48	......	......	......	.....	......	.....	......	.. ...
1878	......	......	......	......	......	......	*0.38	*0.95	......	......	......	......	......
1879	......	.....	......	......	1.60	5.20	1.80	0.60	3.00	1.60	3.00	......	.....
1880	......	2.20	1.40	0.60	.....	1.50	0.80	2.20	2.20	0.20	1.40	1.20	......
1881	......	2.00	2.40	1.60	3.00	0.80	1.60	0.20	3.60	3.80	3.00	2.00	......
1882	2.20	5.80	2.80	3.00	3.20	1.20	5.20	1.60	2.60	0.00	5.80	1.20	34.60
1883	1.20	2.80	2.80	1.80	5.48	3.37	0.33	0.07	0.91	3.60	0.60	0.85	23.81
1884	......	2.40	2.80	1.40	2.00	2.80	4.40	5.60	7.10	1.60	2.40	6.40	.. ...
1885	2.80	0.00											

* Incomplete.

Kansas City, Jackson County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1870	......	......	0.62	0.25	4.25	1.25	3.75	5.83	3.25	6.85	0.50	0.60	......
1871	1.25	1.14	2.33	3.10	2.25	8.93	5.35	2.18	2.50	3.87	1.90	0.75	35.55
1872	0.30	......	......	......	......	3.35	......	......	......	......	......	......	......
1873	2.00	0.24	2.94	7.19	5.25	2.65	3.12	0.88	3.01	0.96	1.16	2.80	32.50
1874	2.83	0.95	3.42	3.00	......	4.12	1.50	1.50	*1.68	†0.62	1.00	*1.05	......
1875	0.30	1.00	......	‡1.26	6.02	6.51	7.50	1.70	1.80	......	......	2.29	......
1877	......	......	......	......	......	......	......	......	3.66	6.96	2.50	2.60	......

* Record for 20 days. † Record for 24 days. ‡ Gauge leaked on the 8th during a light shower.

Lamonte, Pettis County, Mo.

1885	*1.00	*1.30	1.50	6.25	3.25	6.05	5.00	3.25	4.05	1.50	1.35	0.80	38.30
1886	1.50	1.20	2.65	4.65	4.90	1.50	1.70	2.40	2.70	2.10	2.25	0.20	30.85
1887	......	2.51	1.50	4.00	4.15								

* Approximated.

Lebanon, Laclede County, Mo.

1878	1.31	2.05	4.55	6.78	9.39	1.87	4.16	1.07	2.19	2.71	0.51	1.06	41.31
1879	1.27	1.67	1.20	2.00	4.05	6.00	1.65	1.95	1.10	1.65	3.07	......	......
1880	...	3.87											

Macon City, Macon Co., Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.00	3.50	3.81	1.10	7.10	1.52	2.88	1.62	3.28	1.73	1.45	1.11	30.40
1879	0.74	0.25	0.81	1.94	0.87	5.52	3.18	3.18	3.11	0.33	2.84	1.95	25.40
1880	2.53	0.94	1.79	*1.50	4.79	3.78	1.97	3.70	2.55	1.71	1.76	0.50	27.52
1881	0.00	2.23	2.21	2.59	6.47	10.00	2.25	0.25	5.35	8.88	2.25	1.91	44.39
1882	0.18	1.85	4.09	4.62	5.62	7.61	4.19	3.91	2.38	5.38	2.84	1.97	15.00
1883	2.20	5.23	1.98	0.58	5.95	9.56	6.68	2.78	0.35	8.18	1.87	1.13	46.19
1884	1.00	1.85	1.75	1.30	2.57	3.50							

* Approximated.

Mound City, Holt Co., Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1886	*2.00	*0.80	*2.80	*3.30	1.10	1.51	0.32	1.01	2.55	3.55	1.64	0.53	21.11
1887	0.70	1.64	.....	......	5.21	3.11	......	......	......	3.40	3.25		

* Approximated.

Mt. Vernon, Lawrence County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1871	......	......	......	......	......	....	5.05	4.31	0.35	8.65	4.17	0.72	......
1872	1.01	....	......	......	13.70	1.45	8.35	2.55	3.60	1.35	0.65	1.66	......
1873	5.35	3.75	2.00	4.97	3.35	3.00	1.70	2.60	4.75	1.55	1.35	3.85	38.22
1874	3.20	2.50	3.45	4.50	2.60	1.75	1.45	......	......	......	......	......	.....
1875	......	......	......	6.45	4.15	8.00	14.85	1.65	0.80	1.70	......	.....	......

Neosho, Newton County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.31	3.10	2.00	6.86	5.82	7.26	6.33	0.17	2.19	1.99	1.33	2.91	42.90
1879	2.33	2.02	1.81	3.30	3.94	3.45	1.71	3.12	1.37	1.96	6.22	3.85	35.11
1880	1.00	4.67	3.24	6.39	5.66	3.87	5.37	4.56	3.11	3.55	1.81	2.65	45.88
1881	2.00	1.34	3.29	1.53	6.92	7.08	1.12	2.12	4.78	7.68	*1.50	*2.30	47.96

* Approximated.

O'Fallon, St. Charles County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1881	......	......	......	......	......	2.60	1.80	0.01	6.00	7.30	6.10	.....	.....
1882	2.10	7.50	1.90	1.90	1.20	5.20	2.60	2.30	1.80	3.20	3.00	1.50	10.20
1883	......	......	2.10	1.10	3.10	1.70	......	......	......	5.80	......	.....	......
1885	......	......	......	......	.....	......	......	.....	5.80	1.60	2.01	1.01	......

Phelps City, Atchison County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	*1.00	*0.50	*3.75	1.40	3.20	8.10	1.55	0.10	1.65	1.20	0.15	0.90	23.80
1879	0.55	0.22	0.70	2.10	3.80	1.00	1.75	1.70	3.05	1.25	5.25	*2.00	29.67
1880	*1.10	0.20	0.40	1.70	1.55	1.10	1.00	10.50	*2.50	2.50	1.15	*1.30	30.30
1881	*1.30	*4.50	*1.50	*3.20	*5.00	9.05	0.25	2.80	5.60	3.85	*1.50	*0.50	39.05
1882	0.20	0.70	1.05	5.65	3.30	5.35	2.10	1.05	0.15	1.55	0.25	1.65	26.06
1883	0.30	......	......	.....	4.75	17.60	1.90	......	......	.....	......	......	......
1884	*0.90	*1.00	3.65	3.25	0.90	3.70	5.85	4.10	2.20	1.80	0.50	0.80	28.65
1885	0.80	......	......	......	2.00	5.75	3.80						

* Approximated.

Near Protem, Taney County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1881	......	......	......	......	......	......	......	......	4.09	6.21	3.91	2.82	......
1882	3.31	8.98	4.00	6.61	10.56	7.11	8.41	6.12	4.70	7.22	3.52	2.93	73.80
1883	2.57	8.19	3.04	3.81	8.16	6.24	11.60	4.79	1.52	18.11	5.77	4.52	78.32
1884	2.05	10.93	3.95	3.87	5.93	3.57	5.04	4.78	5.14	0.94	4.71	11.37	62.28
1885	2.65	1.47	3.60	5.38	3.73	3.69	8.31	2.37	3.64	1.22	2.50	2.30	40.86
1886	2.45	2.61	4.87	5.44	2.04	5.42	5.91	3.91	8.44	0.10	3.49	1.51	46.19
1887	1.33	4.08	2.84	3.20	8.57	6.07	1.82	8.28	4.69	1.50	3.61	3.69	49.71

Station near Richland, Pulaski County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1872	......	......	......	......	......	......	6.45	2.65	3.50	0.80	0.60	1.75	......
1873	4.60	2.00	2.20	4.40	3.19	4.21	1.55	1.85	4.65	3.35	1.15	8.00	41.15
1874	1.90	3.75	2.70	3.00	......	3.50							

Salem, Dent County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1880	*3.00	*4.00	3.01	4.74	5.76	*4.50	*4.00	*0.70	2.59	2.94	2.29	1.68	39.24
1881	0.45	2.05	1.43	1.80	1.92	5.78	*1.00	2.00	2.05	5.15	3.85	1.50	28.98
1882	1.59	3.74	2.41	1.84	7.04								

* Approximated.

Steelville, Crawford County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1884	......	......	......	......	......	......	......	......	....	1.53	2.87	5.45	......
1885	2.20	1.20	0.88	2.53	2.98	9.55	3.25	1.45	4.73	3.05	0.55	0.95	32.32
1886	2.10	1.63	1.72	2.30	6.20	6.20	0.20	0.95	6.15	0.60	3.52	2.30	33.87
1887	1.40	3.30	2.07	3.88	4.85	1.25	3.10	2.70	2.55	2.15	3.50	2.49	33.24

Waterworks, St. Louis, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1879	1.30	1.20	1.20	2.60	0.35	4.00	1.65	2.00	0.92	1.10	4.25	2.75	23.62
1880	2.90	2.50	2.05	3.19	2.60	2.71	4.92	1.50	2.50	2.25	2.91	1.44	31.47
1881	0.44	4.51	1.94	2.61	4.67	3.86	2.20	0.32	3.74	7.06	6.32	1.67	39.34
1882	2.34	6.99	3.57	3.47	4.22	4.57	1.10	2.07	1.38	3.21	2.77	1.49	37.18
1883	1.10	6.04	2.01	3.87	2.98	6.18	1.37	3.95	0.00	6.07	3.57	1.58	41.72
1884	0.70	3.74	3.14	3.30	2.85	3.49	3.11	1.98	1.28	2.00	2.02	5.21	36.12
1885	2.32	0.44	0.35	4.50	2.71	6.28	2.06	4.19	7.02	5.52	1.75	2.22	39.36
1886	2.60	1.40	3.00	4.62	7.32	6.56	0.58	2.51	8.20	0.51	3.28	2.68	41.29
1887	1.93	3.30	3.26	4.02	4.92	1.90	1.70	1.13	2.10	0.70	3.62	1.90	30.48

Tower Grove, St. Louis County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1861	1.31	1.13	6.00	2.91	3.57	3.78	1.93	4.60	4.83	2.22	1.52	1.26	35.06
1862	3.03	0.51	3.07	4.99	2.57	3.27	4.53	0.63	6.03	2.33	3.47	5.71	40.11
1863	......	3.58	2.19	......	2.45	2.62							

Troy, Lincoln County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.30	2.50	2.82	5.83	3.80	1.90	1.00	3.50	1.75	*0.90	*0.70	3.10	30.10
1883	......	......	......	......	......	......	......	......	......	......	6.50	2.50	......
1887	*1.00	*3.00	2.70	6.20	3.80	2.30	3.80	1.50	2.75	0.50	1.20	2.00	30.75

* Approximated.

Unionville, Putnam County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	0.00	0.80	2.94	1.75	3.70	3.45	*2.70	*3.30	2.00	1.60	1.15	1.40	24.49
1879	0.90	0.70	0.60	2.45	5.45	*7.50	*3.00	*2.30	5.50	1.70	*6.80	*1.30	37.60
1880	......	......	2.70	......	......	......	......	......	......	.....	......	2.78	......
1881	0.50												

* Approximated.

Warrensburg, Johnson County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868	......	......	......	......	......	......	1.75	6.26	2.21	2.05	5.03	2.25	.....
1869	3.52	0.50	2.22	2.59	4.31	7.67	3.01	1.35	......	......	......	......	......
1874	......	...	.....	......	......	.....	3.50	1.40	2.85	0.40	2.45	1.60	......
1875	......	4.77	1.20	2.15	1.50								
1878	4.98	3.49	2.10	3.21	1.20	3.17	2.80	2.33	2.13	0.58	1.10	3.88	30.70
1879	1.13	0.13	0.65	2.67	1.23	6.18	7.35	0.34	2.61	3.97	1.97	2.17	30.73
1880	1.07	1.21	1.23	2.01	2.31	1.28	*2.00	*1.00	*2.00	*2.00	1.71	0.62	21.53
1881	0.11	*4.50	2.59	1.41	3.49	5.35	1.43	*2.00	*6.30	5.92	3.42	2.14	38.66

* Approximated.

Wet Glaze, Camden County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1872	1.60	0.94	2.00	4.00	6.60	2.30	5.70	4.60	2.90	0·50	......	9.30	......
1873	1.10	2.10	1.10	4.65	2.70	3.50	0.90	1.40	3.50	2.70	0.50	8.60	36.05
1874	2.00	2.80	2.80	4.60	2.30	2.50	3.50	5.00	1.30	3.70	1.70	1.30	......
1875	......	2.76	2.80	4.50	5.70	5.20	17.80	1.70	......	1.00	......	2.70	......
1876	......	4.60	......	......	1.30	5.80	12.00	......	3.20	0.80	0.80	......	......
1877	1.00	0.10	2.30	4.20	3.60	......	3.20	2.90	1.90	3.90	3.60	......	......

Wyaconda Prairie, Lewis County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1862	......	......	......	7.80	1.61	8.01	4.57	3.27	10.31	1.72	2.80	6.65	......
1863	......	2.95	3.62	.....	2.36	0.65	0.77	3.34	2.86	7.56	1.26	3.64	...
1864	1.32	0.46	1.83	7.43	2.07	1.12	7.48	3.24	5.24	5.31	3.28	1.06	42.84
1865	0.14	3.16	8.89	......	0.71	5.01	8.54	2.06	7.42	3.96	0.00	1.22	......
1866	3.45	0.79	2.13	......	2.13	1.87	5.67	2.13	......	......	......	......	......
1867	......	3.40	1.37	2.50	......	......	......	......	......	......	.....	.....	......
1868	0.60	0.61	4.07	7.97	6.05	2.32	2.56	2.46	4.61	2.37	5.01	2.33	40.99

*On the Output of the Non-condensing Steam Engine, as a Function of Speed and Pressure.**

By Francis E. Nipher.

In the discussion which follows, the engine is supposed to be running at a fixed cut-off, and without change in the throttle. The pressure changes required to produce a change of speed are supposed to be effected by a change in boiler pressure. The effect of the throttle or the governor with automatic cut-off will be pointed out as we proceed.

The difference between the two belt-pulls, or the load on the brake, is represented by w, r being the brake-arm, or radius of the driving-wheel. If the belt-pulls are F' and F'', then $F' - F'' = w$. It is supposed also that the mean effective pressure required to drive the engine when $w = o$ is constant for all speeds. In an engine with balanced valves and where the amount of lubrication used increases with the speed, this assumption may be tolerated for a general treatment of the case, although the peculiarities of engines will doubtless cause them to depart from this assumption in a more or less irregular way. Engines are usually built for definite speeds, and often behave poorly when run at widely different speeds from those for which they were designed.

For these reasons, some portions of this treatment cannot lay claim to very great precision. It will serve mainly to present the general conditions of the problem, and may serve as a basis for investigating the peculiarities of individual engines.

Let $P_0 =$ mean effective pressure when $w = o$,
$P_0 =$ boiler pressure above atmospheric pressure when $w = o$.
$P =$ mean effective pressure with load w.
$R =$ piston radius,
$l =$ stroke. $n =$ revolutions per minute.

Then, during one stroke of the engine at uniform speed,

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* Read May 20th, 1889.

$$\pi R^2 (P - P_0 =) l \pi r w,$$

or

$$P = P_0 + \frac{rw}{R^2 l} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Multiplying this equation by $\frac{2\pi R^2 l n}{33000}$

$$I \text{HP} = \frac{2\pi R^2 l n P_0}{33000} + \frac{2\pi r n w}{33000} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The indicated horse-power is equal to the brake horse-power plus the power required to drive the engine alone.

In the equation leading to (1) the second member should strictly contain a term $= f(F', F'')$ the exact form of which would depend upon how the belt is applied. It is so small that it cannot usually be measured on an indicator card, and is here omitted. It may be inserted, however, without changing the form of any of the succeeding equations.

The equation for brake horse-power is

$$B \text{HP} = \frac{2\pi r n w}{33000} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$B \text{HP} = \frac{2\pi R^2 l n}{33000} (P - P_0) \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$I \text{HP} = \frac{2\pi R^2 l n P}{33000} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Taking IHP, as a function of n and P, and (5) is the equation of an hyperbolic paraboloid, the constant for which is entirely independent of the condition of the engine or the steam with which it is supplied. It depends solely on the geometry of the engine (the unit of power being fixed). It involves only the volume swept through by the piston-face during one stroke. The performance of all engines in which this volume is the same would always be represented by points on a common surface. These points may be made to move about in any arbitrary manner by variations in boiler pressure and load.

If the boiler pressure is held constant, then n becomes some definite function of w, and the point representing the performance of any engine would traverse some definite line upon the surface.

Equation (4) which represents brake horse-power, is also the equation of an hyperbolic paraboloid, having the same constant as the one represented by (5). The two surfaces have a common pressure axis, and the coördinate planes of HP, n for the two surfaces are separated by the distance P_0. On each of these surfaces, a condition of constant load, w, would be represented by some definite line, and (3) which is the ordinary formula for B HP is a projection of that line upon the coördinate plane of HP, n.

For any definite values of n and P, a vertical ordinate drawn through the surfaces of B HP and I HP would determine simultaneous values of brake and indicated horse-power. The distance between the surfaces measured on this ordinate would represent the power consumed in the engine itself. Passing a plane through these surfaces at right-angles to the speed axis, the intersections with the two surfaces would be parallel lines. The distance between these lines measured parallel to the HP axis is constant, and represents as stated the power consumed in the friction. It is constant for all loads, as experiment shows it to be, and increases uniformly with the speed at constant pressure, or by (4) and (5),

$$\left[\frac{d(I\,\text{HP})}{dP}\right]_n = \left[\frac{d(B\,\text{HP})}{dP}\right]_n = \frac{2\pi R^2 l n}{33000}$$

$$\left[\frac{d(I\,\text{HP})}{dn}\right]_P = \frac{2\pi R^2 l P}{33000}$$

$$\left[\frac{d(B\,\text{HP})}{dn}\right]_P = \frac{2\pi R^2 l(P-P_0)}{33000} = \frac{2\pi r w}{33000}$$

In Fig. 1, oP' and oA'' are the axes of pressure, and HP. AA'' is the line of atmospheric pressure, and VV' is the vacuum line. The lines op'' and $P_0\,p'$ are rectilinear elements in the surfaces of I HP and B HP at constant speed, the ordinates Pp'' and Pp' representing simultaneous values. If the mean effective pressure were reduced to zero, the engine being driven at the same speed by means of the belt, the power required is represented by *od*. The line VB represents B HP as function of boiler pressures, OP and OP' being simultaneous values of mean effective and boiler pressure, measured from the atmospheric line. $V'V$ represents the belt-power required to drive the engine if boiler and mean effective pressure were zero.

Calling h = the atmospheric pressure, and P' = boiler pressure measured from atmospheric pressure, we have

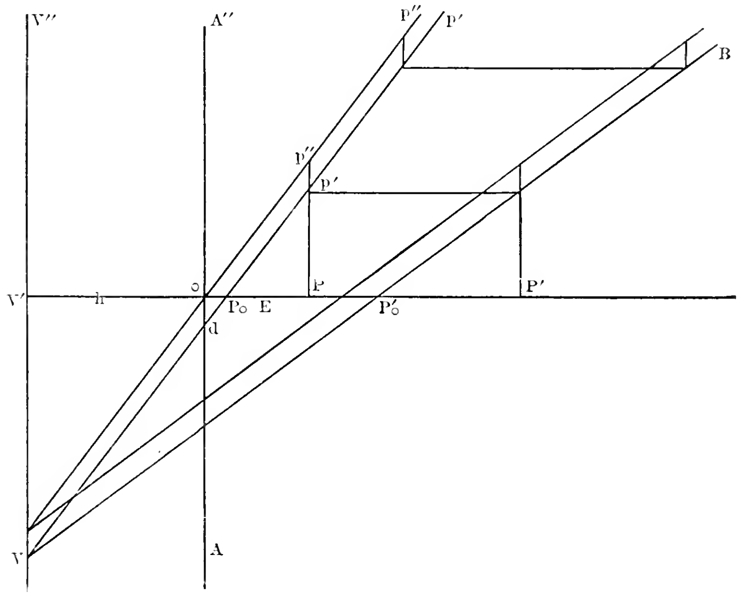
$$\frac{h + P_0}{h + P'_0} = \frac{h + P}{h + P'}$$

or

$$P' = -h + \frac{h + P}{h + P_0}(h + P'_0) \qquad . \qquad . \qquad (6)$$

In this equation the value of P is known from (1). Po is determined by means of the indicator. It remains to determine P'_0, the boiler pressure required to drive the engine at the fixed speed represented in Fig. 1, when $w = o$.

Fig. 1.



If the engine were driven at a very slow speed, the cylinder pressure would be identical with boiler pressure until the point of cut-off. The mean effective pressure would be less, and the back pressure would be h. Increasing the boiler pressure, the back pressure increases by a quantity which is proportional to the speed.

Measuring P'_0 from the atmospheric line,

$$P'_0 = cn + P_0 + E + bn \quad . \quad . \quad . \quad . \quad . \qquad (7)$$

where cn is the mean back pressure, Po the mean effective pressure, E a function of the inverse expansion ratio, and bn is a term applying to the entry port which is entirely analogous to cn. The constants c and b depend upon the size of the ports, b also depending to a less extent upon the pipes connecting the steam-chest and boiler. In a throttle governor, the value of b is changed in order to change mean effective pressure. In a governor which varies the cut-off. both E and b are changed by the action of the governor.

The action of any governor changes the inclination of the line V, B in Fig. 1. For a constant boiler pressure P', if the cut-off comes earlier, or, if the steam is throttled, the line V, B becomes less steep, and the points p' and p'' sink to represent a smaller output.* In Fig. 2, the action of the governor changes the position of the line $w = o$, and in fact the entire surface of HP as function of P'.

Making the indicated substitutions in (6)

$$P' = -h + \frac{h + P_0 + \frac{rw}{R^2 l}}{h + P_0} (h + Po + E + (b + c)n) \quad . \quad . \qquad (8)$$

Solving this equation for w.

$$w = \frac{R^2 l}{r} \left[\frac{(h + P_0)\ (h + P')}{h + P_0 + E + (b + c)\ n} - (h + Po) \right] \quad . \quad . \qquad (9)$$

Multiplying (9) by $\frac{2 \pi nr}{33000}$

$$BHP = \frac{2 \pi R^2 l}{33000} \left[\frac{(h + P_0)\ (h + P')\ n}{h + P_0 + E + (b + c)\ n} - (h + P_0)\ n \right] \qquad (10)$$

* In an experimental engine the head of the screw which controls the steam should be provided with a divided scale like a micrometer.

For any constant boiler pressure there will be some definite speed which will make BHP a maximum. The condition is

$$\left[\frac{d\ B\text{HP}}{dn}\right]_{P'} = 0.$$

Imposing this condition we have

$$(h+P')\ (h+Po+E) = [h+Po+E+(b+c)\ n]^2 \quad . \quad . \quad (11)$$

The speed must be such that the boiler pressure required to drive the unloaded engine at that speed, is a mean proportional between the constant boiler pressure under consideration, and the boiler pressure required to start the unloaded engine, [see (7),] all pressures being measured from vacuum. The load corresponding to this maximum is of course found by imposing this condition in (9) by the elimination of n.

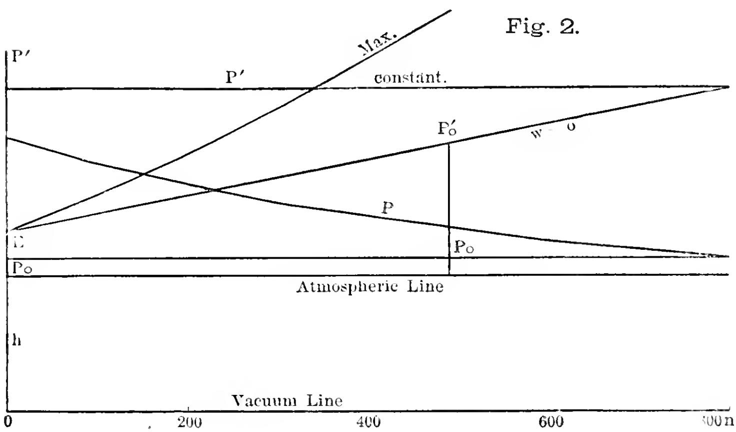


Fig. 2.

Equation (11) gives the relation between n and P' for a maximum output at any boiler pressure P'. It is the equation of a parabola, which crosses the pressure axis at its intersection with the line of zero load (7). The slope of this parabola is

$$\frac{dP'}{dn} = 2\,(b+c) + 2\,\frac{(b+c)^2}{h+P_0+E}\,n \quad . \quad . \quad . \quad . \quad (12)$$

When $n = o$ the slope is therefore twice that of the line of zero load.

The value of n in (11) is

$$n = -\frac{h + P_0 + E}{b + c} \pm \frac{1}{b + c}\sqrt{(h + P_0 + E)(h + P')} \quad . \quad (13)$$

Hence the vertex of this parabola is at the intersection of the line of zero load (7) with the vacuum line. Its position is

$$P' = -h$$

$$n'' = -\frac{h + P_0 + E}{b + c}$$

This value of n'' is rather large and therefore the part of the parabola which corresponds to a possible range of engine speed will be very nearly a straight line. The axis of the parabola is of course parallel to the pressure axis. It will be observed that all lines of constant load represented by (8) intersect the vertical line (parallel to the HP axis) which contains the vertex of the parabola of maximum effort. In (8) the condition $P' = -h$ at once gives the condition

$$n = -\frac{h + P_0 + E}{b + c}$$

and this entirely independent of w.

The observations made regarding the parabola of maximum output justify the presentation of another formula which was deduced empirically from a large number of brake determinations. The discovery of that formula was in fact the occasion for the present investigation.

The experiments were made by taking constant loads on a fixed brake-arm varying the speed of the engine from 200 to 800 revolutions, for each load, by means of a throttle. The pressure of the supply steam was measured by means of a gauge between the throttle and the steam-chest, the cut-off remaining fixed.

The observations for constant load all satisfied, equations of the form

$$P' = a + b'n \quad . \quad . \quad . \quad . \quad (14)$$

This equation is identical with (8). Computing from each equation the value of n for a given pressure, these values of n were plotted with their respective values of w, and gave a line which could not be distinguished from a right line. Its equation was of the form

$$w = k - k'n \quad . \quad . \quad . \quad . \quad . \qquad (15)$$

This equation corresponds to (9) with P' constant, which is however the equation of an equilateral hyperbola, the asymptotes of which are

$$w = \infty \quad \text{if} \quad n = -\frac{h + P_0 + E}{b + c}$$

$$n = \infty \quad \text{if} \quad w = -\frac{R^2 l}{r}(h + P_0)$$

It is manifest therefore that the part of the parabola examined would differ so little from a right line that (15) would satisfy any observations made upon an engine.

Multiplying (15) through by $\frac{2\pi rn}{33000}$ we have

$$BHP = \frac{2\pi rkn}{33000} - \frac{2\pi rkn^2}{33000} \quad . \quad . \quad . \quad . \quad . \quad . \qquad (16)$$

This is the equation of a parabola and corresponds to (10), which is likewise a parabola when P' is constant.

Differentiating (16), the condition of maximum output is found to be

$$n' = \frac{1}{2}\frac{k}{k'} \quad . \quad . \quad . \quad . \quad . \quad . \qquad (17)$$

or the speed must be one-half that which the engine should have at the same boiler pressure if $w = o$.

The condition for maximum, according to this, would be

$$P' = a_0 + 2b'_0 n \quad . \quad . \quad . \quad . \quad . \qquad (18)$$

It will be observed that this is a right-line, tangent to the parabola (11) where $n = o$. According to (11), these values of n represented by (17) would be somewhat too large.

Solving (15) for n and multiplying by $\frac{2\pi rw}{33000}$

$$HP = \frac{2\pi rk}{k'}w + \frac{2\pi r}{k'}w^2 \quad . \quad . \quad . \quad . \quad . \quad . \qquad (19)$$

The condition for maximum obtained from this equation is

$$w' = \frac{1}{2}k \quad . \quad . \quad . \quad . \quad . \quad . \qquad (20)$$

where w' is one-half the load which will bring the engine to rest at that pressure.

This value of w is somewhat too small to satisfy (11), although as stated the error is probably always too small to have any importance. Substituting these two values of n' and w' in (3) and we undoubtedly have a very close approximation to the maximum output at any pressure P',

$$B\,\mathrm{HP} = \tfrac{1}{2}\ \frac{\pi}{33000}\ .\ \frac{k}{k'}\ .\ kr$$

where $\frac{k}{k'}$ is the speed at that pressure when $w = o$ as computed from (7) and kr = the turning moment which for that pressure must be applied to the shaft in order to bring the engine to rest. This can be computed from (9). It is wr when $n = o$.

In a similar manner we may represent indicated horse-power as a function of boiler pressure. Solving (6) for P and substituting, as before,

$$P = -h + \frac{(h + P_0)\ (h + P')}{h + P_0 + E + (b + c)\ n} \quad . \quad . \quad . \quad (21)$$

It may be remarked in passing that, for a constant value of P', this is an hyperbola which represents the relation between mean effective pressure and speed, with varying load. The asymptotes of the curve are the vacuum line and the axis of the parabola of maximum output, where

$$n = -\frac{h + P_0 + E}{b + c}$$

The only part of this curve which has any practical significance is that included between the pressure axis and the line where $P = P_0$. This part of the curve is marked P on Fig. 2, P' being the line representing the corresponding fixed boiler pressure. During the operation here considered, the point representing the performance of the engine would travel through a definite path on the surface represented by (4). The hyperbola marked P on Fig. 2 would be a projection of that path on the plane P, n, while the parabola (10) with P' constant would be a projection of that path on the plane HP, n.

The engine might indeed be driven by a belt at a greater speed than that given it by the steam when $w = o$, and the mean effective pressure would continually fall as represented by the hyperbola. The part of the curve corresponding to negative values of n has no physical significance. The engine when brought to rest with any fixed load w, by a decrease of boiler pressure, would not reverse if the boiler pressure were still more reduced, until it became less than the atmospheric pressure.

Multiplying (21) by $\frac{2\pi R^2 l n}{33000}$

$$IHP = \frac{\pi R^2 l}{33000}\left\{-hn + \frac{(h+P_0)(h+P')n}{h+P_0+E(b+c)n}\right\} \quad . \quad . \quad . \quad (22)$$

This equation corresponds to (10).

The condition of maximum IHP for constant P' is

$$\frac{(h+P_0+E)(h+P_0)(h+P')}{h} = \left[h+P_0+E+(b+c)n\right]^2 \quad (23)$$

This like (11) is the equation of a parabola. The value of n is

$$n = -\frac{h+P_0+E}{b+c} \pm \frac{1}{b+c}\sqrt{\frac{(h+P_0+E)(h+P_0)(h+P')}{h}} \quad (24)$$

The slope of this parabola is

$$\frac{dP'}{dn} = 2\frac{h}{h+P_0}(b+c) + 2\frac{h}{h+P_0}\frac{(b+c)^2}{h+P_0+E}n^2 \quad . \quad (25)$$

which when $n = o$ is

$$\left[\frac{dP'}{dn}\right]_{n=o} = 2(b+c)\frac{h}{h+P_0} \quad . \quad . \quad . \quad . \quad (26)$$

while the line of zero load has the equation

$$h + P' = \frac{h}{h+P_0}\left\{h+P_0+E+(b+c)n\right\} \quad . \quad . \quad . \quad (27)$$

as is readily determined from (22).

The writer has examined engines in which the friction pressure increases with the pressure of the supply steam at constant load. The value of P_0 then becomes $P_0 + en$, and the surface of brake horse-power as a function of mean effective pressure is then represented by equations similar to that which in this paper represent brake horse-power as a function of boiler pressure. The discussion then becomes more complex, although it can be made on the lines here laid down. It is better to avoid this discussion by refraining from building such engines.

The experience of the writer with condensing-engines has been very limited, but it would appear that the equations here given will apply also to them.

The four surfaces here discussed may all be constructed by means of threads to represent the two sets of rectilinear elements in each. These are constant speed, and constant load. Such models represent the working conditions of an engine in a most interesting way.

The long-continued Action of the Electric Discharge on Iodine.

By C. Luedeking, Ph.D. (Leipzig).

Some time ago, the author attempted the study of the effects of the electric discharge on iodine vapor, when continued over a long space of time. The researches of V. Meyer showed that with increasing temperature the vapor density of iodine becomes rapidly less than what is demanded by theory, finally reaching two-thirds of the theoretical value; a fact explained by the partial supposed dissociation of molecular into atomic iodine.

Later, J. J. Thompson (*Proc. Royal Soc.*, vol. xiii., pp. 343–345), showed that the silent discharge produces the same phenomena of anomalous densities that were observed by V. Meyer for higher temperatures. Several hours of time were necessary for the vapor to regain its normal density.

It was desired by the author to act upon the vapor of iodine, through a long period of time, by means of the electric discharge, and subject the result to analysis, with a view to establishing, if possible, any changes brought about.

Four Grove cells, of Browning's make, were used as electromotive force. The circuit was passed through a Ruhmkorf coil capable of giving sparks two inches long by this arrangement; the wires of the coil were connected with heavy platinum wires, sealed in a small heavy glass tube, with their ends opposite, and ½ inch apart from one another. In this tube 0.036 grm. of iodine was sealed hermetically. By gentle heat it was then vaporized in part, the contents assuming the appearance of an intensely deep violet color. The spark was now passed incessantly for three weeks, day and night, and the character of the light phenomena watched as carefully as possible. As the experiment advanced the color of the contents of the tube gradually changed, losing the rich deep violet tint it had at first, very much resembling bromine vapor in appearance, and, passing through this stage, becoming more and more faint, until, at the end of the aforementioned time, the tube was entirely colorless, and evidently all iodine had disappeared. What had become of it?

When reading Mr. C. P. Smyth's Address before the British Association, I recalled these experiments of mine that had been made some time ago. His experiences are quite analogous to my own. In 1880, his iodine tube showed 148 iodine lines, and 3 exceedingly faint reproductions of the chief hydrogen lines: "yet, in the present year," he goes on to say, "there is not one iodine line left in that tube, and its spectrum range is filled with nothing but both high and low temperature hydrogen lines of astonishing brilliancy, while of the large amount of iodine granules hermetically sealed into the tube in 1878, only a very small amount of apparently inert dust is now left." Further, he states: "Whether this change is an infinitesimally small part of the progress of everything to turn into hydrogen, and for assisting thereby the whole solar system to explode some day into a so-called and spectroscopically bright-lined hydrogen star, I will by no means weary the Section by enquiring now."

It is clearly expressed that iodine has disappeared from a certain tube; that, whereas, this tube contained at first only faint indications of hydrogen, it, after the disappearance of the iodine, showed the presence of this element in remarkable brilliancy or amount. The inference must be that iodine has been decomposed and that hydrogen is present as product of decomposition.

As our experimental results are similar in respect to disappearance of iodine, it will be of interest for me to describe my analytical manipulations of the contents of my iodine tube, and to show what my conclusions necessarily were.

As stated, the iodine had disappeared entirely from my tube. The platinum poles in the tube were much corroded and roughened; during the discharge the ends were constantly at a bright red heat; the spark itself had a livid appearance, was uncertain in its course, changing frequently. The sides of the tube were affected as if by hydrofluoric acid, and there was in the tube what seemed to me also only a small amount of dust.

The tube was opened under water by nipping off the end; there was a partial vacuum, the water entering and filling it about one-fifth, by a rough estimate. I inferred at the time that the oxygen of the air, originally contained in the tube, had disappeared, and that what was left was nitrogen. This result is contrary to what we should expect had hydrogen been formed by dissociation of the iodine. The confined gases would have been under a pressure.

The contents of the tube were thoroughly extracted by water, the solution so obtained made slightly alkaline, and sulphuretted hydrogen passed to saturation. After expulsion of the gas and slightly acidifying with nitric acid, nitrate of silver was added, and the precipitate filtered, washed, dried and weighed. The quantity of precipitate produced was nearly equal to what theory requires for iodide of silver; it weighed 0.061 grm.

Evidently, then, in my experiment the disappearance of the element iodine was not due to any other cause than its uniting with the constituents of the glass. Under the influence of the electric discharge iodine certainly acquires superior chemical affinities, attacking the substance of the glass and forming iodides, and, from the disappearance of one-fifth of the volume of gas, I should say, also some iodates. To meet this eventuality, I reduced by sulphuretted hydrogen previous to precipitation.

The changed brilliancy of the spectral hydrogen lines that Mr. Smyth observed must, then, it seems to me, be attributed to another cause than a generation of hydrogen by a decomposition of iodine. First of all, it is certain that the changed condition of the tension in the tube has something to do with it.

I determined to decide the matter experimentally. An excess of iodine was sealed up in the same kind of tube that I used above. On passing the discharge at the ordinary temperature, only faint indications of hydrogen were observed in the spectroscope. The tube was then heated gently, so that a great part of the iodine was volatilized. As the temperature rose, and the iodine vapor became more and more dense, to my surprise the hydrogen blazed in the spectrum with remarkable brilliancy. On cooling, the spectrum slowly changed back to its original appearance; hydrogen was again only faintly perceptible. It was clear then why the hydrogen lines in Mr. Smyth's tube should become so brilliant after the disappearance of the iodine. This latter is capable of binding hydriodic acid, which is the form in which the hydrogen is introduced into the tube. When by the process of action of the iodine on the walls of the glass tube it becomes united with alkalies, this hydrogen, finally, is liberated entirely, and, *instead of an iodine tube, we have a hydrogen tube developed.*

On taking a tube containing iodine in an atmosphere of hydrogen, I found that at first the hydrogen lines wery very bright at ordinary temperatures. However, after a short time, and on continued passage of the spark, the lines became more and more faint, and finally scarcely perceptible. On then heating the tube the hydrogen lines became very brilliant, and on cooling again disappeared almost entirely. On opening such a tube, dense fumes of hydriodic acid were emitted.

These experiments, I think, show conclusively: firstly, *the cause of disappearance of iodine in tubes on long-continued sparking;* and, secondly, *why the iodine lines are replaced by hydrogeu lines during that process.*

I shall probably be in a position to make further communication on the sparking of iodine in the near future.

Chemical Laboratory Washington University, St. Louis, Mo., U. S. A.

Flowers and Insects — UMBELLIFERÆ.*

By CHARLES ROBERTSON.

The Umbelliferæ have remarkably uniform flowers, the nectar being generally exposed, or at most only slightly concealed by the incurved petals; and, since they bloom in succession from early spring to late autumn, are particularly well suited for an investigation which aims to discover the effect of the time of blooming on the character of the visitors. It is obvious that a flower must depend for visitors not only upon the fauna of the region in which it grows, but upon the insects which are flying while it blooms.† Accordingly, I have arranged the plants in the order of blooming, or at least in the order in which they were observed. This will enable us to consider the order in which they succeed one another, their relations to the particular insect fauna upon which they depend, and to the general insect fauna which reaches its maximum of variety in the hot summer. We can compare a plant with one blooming earlier or later, can discover peculiarities in the lists which are due to time of blooming, and can eliminate this cause to ascertain the effect of difference of structure.

For aid in the determination of the bees I am indebted to Mr. E. T. Cresson, of the flies to Dr. S. W. Williston, of the beetles and bugs to Mr. C. A. Hart. The Chalcids, as far as made out, were named for me by Mr. L. O. Howard. My collecting and identification of the minute hymenoptera and diptera are very imperfect. The flowers with exposed nectar are very abundantly visited by these forms, but to collect them requires special attention to them. Then, they have been so imperfectly studied, that it is hard to determine them or to assort them accurately.

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* Compare especially Müller: Fertilization of Flowers, Weitere Beobachtungen, and Alpenblumen. Also Schulz: Beiträge zur Kentniss der Bestaübungseinrichtungen und der Geschlechtsvertheilung bei den Pflanzen.

† The importance of the time of blooming is especially emphasized by MacLeod: Statistiche Beschouwingen omtrent de Bevruchting der Bloemen door de Insecten, Botanisch Jaarboek, eerste jargang, 1889, Gent.

I withhold for the present the lists of visitors in order to complete the determination of certain groups, and to raise the number in certain lists, so that the comparisons can be more satisfactorily made. The tables give the number of species of the several groups. Unless otherwise stated, the observations were made near Carlinville, Ills.

Erigenia bulbosa, Nutt.—On the first warm days of spring this plant raises its small white umbels just above the leaves. The plants often form rather large patches, so that they are very attractive to insects, furnishing both honey and pollen in great abundance. All of the flowers are hermaphrodite, and, from a careful examination, I am satisfied that Foerste* is correct in regarding them as proterogynous.

The petals are longer than in most umbellifers and are not so widely expanded, so that the disc is not so freely exposed as in many of the following species. In the female stage especially, the petals are more erect, and the incurved stamens aid in concealing the nectar.

A flower blooming so early as Erigenia does, cannot be sure to find a set of flower-loving insects waiting for it. for anthophilous insects cannot afford to appear until they are sure of a floral diet. But any weather warm enough to bring out Erigenia flowers is certain to bring out a set of insects which are able to do good work until the flower-insects come. The first day I found Erigenia in bloom in 1889 was on March 21st, when I noted as visitors Apis mellifica, Gonia frontosa, Lucilia cornicina, Scatophaga squalida, and a Sarcophagid. With the exception perhaps of Gonia, all of these insects may be observed on any warm day during the winter. The hive-bee is introduced and so must always be regarded as an intruder on native flowers. None of the other insects depend upon a floral diet. We see, therefore, that Erigenia is sure of the visits of flesh-flies and dung-flies at any time it may appear. It would be effectually cross-fertilized if it depended upon Lucilia cornicina alone. The plant has an advantage over Dicentra Cucullaria,† which has to wait for long-tongued bees. On March 23d I found among the visitors Andrena hirticeps ♂ and Brachypalpus frontosus—the first of the native flower-insects. On the 26th I found 7 Andrenidæ and 2 Syrphidæ, so that this was the first day when the set of visitors showed an anthophilous character.

As a result of early blooming, however, Erigenia is so far from suffering in the character of its visitors that it is the highest specialized of the family, for it shows the largest proportion of bees. Of 62 species of insects captured on the flowers, 28 are hymenoptera, and all of these are bees except a single Chrysid. During the time when this plant is in bloom I have observed no other hymenoptera flying except Tenthredinidæ and Parasitica; these appear to be rare. The preponderance of bees, therefore,

* Bot. Gazette, vii., 70.

† Bot. Gazette, xiv., 125.

is not a result of structural adaptation to them, but of the paucity of the early fauna in lower hymenoptera. By referring to the table it will be seen that only two other species show as many bees, viz., Zizia and Pastinaca. In the first place, these are exposed to a more numerous bee-fauna. But while Erigenia shows 27 bees in competition with 1 hymenopteron and 34 other species, Zizia shows 35 bees in competition with 32 hymenoptera and 64 other species, and Pastinaca 30 bees against 97 hymenoptera and 148 other insects. In Erigenia bees are nearly $\frac{1}{2}$, in Zizia nearly $\frac{1}{3}$, in Pastinaca less than $\frac{1}{9}$ of the number of visitors.

Erigenia agrees with all of the earlier species, except those with concealed nectar, in showing a preponderance of flies over hymenoptera, and this is also a result of the absence of competition of the lower hymenoptera. The list of visitors is peculiarly rich in bees of the genus Andrena, another result of early blooming.

Chærophyllum procumbens, Crantz.—The plant grows in rather thin patches in dark woods. The umbels contain three or four small flowers, which bloom in succession and are very inconspicuous. The flowers are hermaphrodite, imperfectly proterandrous or homogamous, with short stamens and styles. Sometimes I have found a dehiscent anther in contact with the stigma, but even then most of the stigmatic surface remains bare and ready to receive pollen from other flowers. However, all of the flowers appear fruitful even in bad weather, so I think self-fertilization always occurs in the absence of insects.

The plant blooms next after Erigenia. The inconspicuousness of the flowers is compensated for by a rich supply of nectar, so that I was enabled to take 50 species of insects in three days. The nectar is more freely exposed, and, as a consequence, we find fewer bees than in Erigenia and an increased proportion of other insects. This is first to show Parasitica.

Zizia aurea, Koch.—The plants grow in rather large patches, which are made conspicuous by the yellow umbels. Five umbels of each order produced an average of flowers and umbellets as follows:

1st order—294 male and	37	hermaphrodite flowers	in	15	umbellets.
2d order—170 " "	178	"	" "	18	"
3d order— 89 " "	101	"	" "	14	"

The primary umbel commonly bears only male flowers: the proportion of hermaphrodite flowers increases in umbels of 2d and 3d orders. The fruitful umbellets have male flowers within, except a single central flower which is hermaphrodite. The hermaphrodite flowers are proterogynous. While the primary umbel is discharging pollen, the hermaphrodite flowers of the secondary umbels protrude their receptive stigmas. Then they and the male flowers discharge pollen to supply the first stage of flowers of the umbels of the 3d order.

The nectar is concealed by the inflected petals, and in the first stage by the incurved stamens. This plant is first to show Scoliidæ, Pompilidæ, Crabronidæ, and Eumenidæ, which are now flying. The number of bees is larger than in any other species in the table. Compared with Erigenia, this is owing to concealment of nectar and to the presence of a more numerous bee-fauna. Compared with Eryngium, which has more deeply-seated honey, it is owing to a smaller number of competitors, resulting from early blooming. The proportion of bees to other hymenoptera is reduced by the appearance of lower forms. The proportion of diptera is reduced by concealment of nectar.

Polytænia Nuttallii, DC.—This plant agrees with Zizia aurea in color, proterogyny, time of blooming, mode of nectar concealment, and in the general character of its visitors. Five umbels of each order produced an average of flowers and umbellets as follows:

1st order—335	male and	9	hermaphrodite	flowers	in	14	umbellets.
2d order—275	" "	120	"	"	"	18	"
3d order— 48	" "	55	"	"	"	11	"

The primary umbel is, as a rule, entirely male, the proportion of hermaphrodite flowers increasing in the secondary and tertiary umbels. On a plant bearing umbels of the 4th order, the primary and all of the secondary umbels bore only male flowers; an umbel of the 3d order bore 384 male and 74 hermaphrodite flowers in 18 umbellets; one of the 4th order bore 63 male and 54 hermaphrodite flowers in 12 umbellets.

Osmorrhiza longistylis, DC. — Five umbels of each order bore an average of flowers and umbellets as follows;

1st order—58	male and	27	hermaphrodite	flowers	in	6	umbellets.
2d order—47	" "	18	"	"	"	6	"
3d order—38	" "	15	"	"	"	5	"
4th order—29	" "	11	"	"	"	5	"

The hermaphrodite flowers are proterandrous, and the proportion of male flowers remains about the same in umbels of all orders. The flowers are white. The nectar is fully exposed, and, as a consequence, the number of diptera equals the number of hymenoptera.

Sanicula Marilandica, L.—The umbels contain 1 to 4 hermaphrodite flowers surrounded by from 20 to 70 male flowers. The styles of the hermaphrodite flowers are strongly exserted from the start, and, although without receptive stigmas at first, the stigmas develop before dehiscence, so that the flower is proterogynous. When the stamens become dehiscent, the styles are strongly recurved, holding the stigmas down against the sides of the ovary. Sometimes the petals hold an anther so firmly between them that it is not released until it has lost its pollen.

S. europæa has the styles exserted at first, but Schulz* regards it as proterandrous.

The petals are incurved so that they cover the disc, making the nectar less accessible to the shortest tongue. Accordingly, the list shows more hymenoptera than diptera. Although the heads are by no means showy, a rich supply of nectar insures an abundance of industrious visitors.

* l. c.

Heracleum lanatum, Mx.—This plant bears large umbels of white flowers. Well developed plants have 2 or 3 secondary umbels and sometimes one of the third order. Five umbels of each order bore an average of flowers and umbellets as follows:

1st order—	0 male	and	420 hermaphrodite	flowers	in	19	umbellets.
2d order—	120 "	"	303 "	"	"	20	"
3d order—	389 "	"	46 "	"	"	20	"

As a rule, the primary umbel is entirely hermaphrodite, and umbels of the third order are entirely male. A single umbel (primary), borne on a weak plant, produced 160 male and 94 hermaphrodite flowers in 14 umbellets. The opposite of what occurs in Zizia ana Polytænia, the proportion of hermaphrodite flowers decreases from the primary umbel. The hermaphrodite flowers are proterandrous.

This is the first plant to show Larridæ and Sphecidæ. On account of the exposed situation of the nectar, we find a diminution in the proportion of bees and an increase in Parasitica, Crabronidæ, and especially of diptera. I found more flies on Heracleum than on any other umbellifer except Pastinaca. But Pastinaca shows only 7 more flies in a much larger list. Heracleum is especially rich in Syrphidæ, showing 21 species in a list of 174 visitors, while Pastinaca shows only 22 species in a list of 275. The list is also rich in Crabronidæ, especially species of Crabro. Cicuta shows an equal number, Crabro being partly replaced by Oxybelus.

Pimpinella integerrima, Benth. & Hook.—This agrees in a general way with Zizia and Polytænia, and should be compared with them. Five umbels of each order produced an average of flowers and umbellets as follows:

1st order—	409 male	and	0 hermaphrodite	flowers	in	14	umbellets.
2d order—	174 "	"	72 "	"	"	14	"
3d order—	35 "	"	47 "	"	"	9	"

A primary umbel on a plant bearing only 1 umbel produced 36 hermaphrodite flowers, with many male ones, in 17 umbellets. The hermaphrodite flowers are proterogynous.

Eulophus Americanus, Nutt.—The flowers are white. Five umbels of each order produced an average of flowers and umbellets as follows:

1st order—	25 male	and	182 hermaphrodite	flowers	in	13	umbellets.
2d order—	159 "	"	13 "	"	"	12	"
3d order—	51 "	"	0 "	"	"	7	"

Commonly, umbels of 1st order contain only hermaphrodite flowers, those of the 2d order only male flowers. Umbels of the 3d order are rare and entirely male. The hermaphrodite flowers are proterandrous.

From their early blooming and fully exposed nectar, Eulophus and Heracleum show the greatest proportion of flies. Eulophus shows 52 flies in a list of 97. Tiedmannia, which is exposed to a richer hymenopterous fauna, shows 52 flies in a list of 156.

Thaspium aureum, Nutt.; var. *trifoliatum*, C. & R.—Resembles Zizia, Polytænia, and Pimpinella. Five umbels of each order bore an average of flowers and umbellets as follows:

1st order—174 male	and 37 hermaphrodite	flowers	in 11	umbellets.
2d order— 98 "	" 90 "	"	" 10	"
3d order— 57 "	" 98 "	"	" 12	"

var. *atropurpureum*, C. & R.

1st order—170 male	and 13 hermaphrodite	flowers	in 11	umbellets.
2d order—129 "	" 80 "	"	" 12	"
3d order— 94 "	" 85 "	"	" 11	"

Umbels of the 1st order are commonly male. The hermaphrodite flowers are proterogynous.*

Pastinaca sativa, L. ("adv. from Eur.")—Schulz† has observed that the primary umbels contain principally hermaphrodite flowers, while the number of male flowers increases in umbels of the 3d order. The hermaphrodite flowers are proterandrous, as is well known.

The large umbels of yellow flowers are very attractive to insects. The nectar is freely exposed. In comparing the lists it must be remembered that this is the largest one, much more time having been given to it than to any other plant. It shows the first Nyssonidæ, and an increase in all hymenoptera except Crabronidæ, Andrenidæ, and Apidæ. Although observed nearly four times as much as Heracleum, it shows only 5 more flies. Heracleum shows 20 more flies than hymenoptera, while Pastinaca shows 35 more hymenoptera than flies.

In the Fertilization of Flowers, 284, and Weitere Beobachtungen, i., 36, Müller gives a list of 7 diptera and 8 hymenoptera. In the former he says: "So the dull yellow flowers of this plant, like those of Buplurum and Anethum, are visited by Diptera and Hymenoptera, not by Beetles." Again, on p. 287, he says: "As a peculiarity which influences this assemblage of insects, I must mention the yellow color, for I have never found the flowers of Buplurum, Silaus, or Pastinaca, visited by beetles." This generalization was founded in the case of Buplurum falcatum on a list of only 8 visitors, and he afterwards, in the Weit. Beobachtungen, records the occurrence of beetles on B. falcatum as well as on B. rotundifolium. In a list of 46 species found in Anethum, no beetle occurs, but this may be accidental. The list of visitors of Silaus is very fragmentary, containing only 3 insects. In Bot. Gazette, vii., 24, Foerste mentions beetles as visitors of Pastinaca, and on page 27 of the same Prof. Trelease refers to Müller's statement. Finally, I have found Pastinaca to be visited by 40 species of beetles, which is nearly twice as many as Müller ever found on any plant of the order.

* Foerste seems to have regarded some species of Thaspium(?) as proterogynous. See Bot. Gazette, vii., 71.

† l. c.

Cicuta maculata, L.—Five umbels of each order bore an average of flowers and umbellets as follows:

1st order—	4	male and	485	hermaphrodite	flowers	in	16	umbellets.
2d order—	127	" "	824	"	"	"	28	"
3d order—	360	" "	448	"	"	"	27	"
4th order—	438	" "	43	"	"	"	22	"

As a rule, umbels of 1st order bear only hermaphrodite flowers, those of 4th order only male flowers. The hermaphrodite flowers are proterandrous.

This plant bears many large umbels of white flowers with fully exposed nectar. Cicuta was observed nearly three times as much as Heracleum, but Heracleum shows 15 more flies. As we have observed, Heracleum has 20 more flies than hymenoptera, but Cicuta has 71 more hymenoptera than flies, nearly twice as many. While diptera reach their maximum on Heracleum, hymenoptera reach their maximum on Cicuta. It is the first to show Bembecidæ. Compared with Pastinaca, which blooms earlier, it shows an increase in all hymenoptera except Parasitica, Philanthidæ, Eumenidæ, Andrenidæ, and Apidæ. The Parasitica would no doubtequal the numbers taken on Pastinica, or Sium, if I had given the same attention to the collection of them, and then the extent of the preponderance of hymenoptera on Cicuta would have been better indicated.

Eryngium yuccæfolium, Mex.—Agrees in general with E. campestre, as described and figured by Müller in the "Fertilization of Flowers," 271. Although the styles are strongly exserted from the first, they do not seem to become receptive until after the pollen is discharged, so that the flower is proterandrous. The early elongation of the styles seems to be to obstruct the passage to the nectar, so as more effectually to exclude short-tongued insects. The nectar is more deeply seated than in any other species here considered, and, as a consequence, we find a marked increase in insects of large size and long tongues. Compared with Zizia, we find a smaller number and proportion of bees, on account of the increased abundance of other hymenoptera. We also find fewer diptera, on account of deeper honey and competition of hymenoptera.[4]

But the effect of deep-seated honey is best shown by comparison with Cicuta, which was observed nearly equally and under equally favorable conditions, and, since they bloom at the same time, they are exposed to the same kinds of insects, so that the differences in the lists may be referred to differences in floral structure. The Parasitica are limited to Leucospis. Chrysididæ and Nyssonidæ are absent. Pompilidæ fall from 20 to 6; Larridæ from 12 to 3; Crabronidæ from 14 to 4; Sphecidæ from 12 to 8. The larger and longer-tongued species—Scoliidæ, Philanthidæ, and Eumenidæ—remain about the same, while the large Bembecidæ show an increase. There is marked increase in long-tongues, such as Apidæ, Bombylidæ, Conopidæ, and lepidoptera. Indeed, the list shows more Bombylidæ, Conopidæ, and lepidoptera, than on any other umbellifer, and more Apidæ than any other except Zizia.

E. campestre, according to Schulz,* has the first umbels with only hermaphrodite flowers, and the last with only male ones. Müller's list of 24 species wholly fails to indicate the character of visitors favored by the floral structure.

Sium cicutæfolium, Gmelin.—Five umbels of each order bore an average of flowers and umbellets as follows:

1st order—	0 male and	415 hermaphrodite flowers in	13 umbellets.
2d order—	0 " "	689 " " "	22 "
3d order—	0 " "	521 " " "	21 "
4th order—	279 " "	58 " " "	16 "

Umbels of the 4th order are usually entirely male. In less vigorous plants, umbels of the 4th order are wanting, and those of the 3d are entirely of male flowers. The hermaphrodite flowers are proterandrous.

This plant closely resembles Cicuta, but the list is much smaller, since they do not grow under conditions as favorable for observation.

The list shows more species of Bombylidæ than in Eryngium, but the five species were represented by only one individual of each.

Tiedmannia rigida, C. & R.—Five umbels of each order bore an average of flowers and umbellets as follows:

1st order—	27 male and	594 hermaphrodite flowers in	23 umbellets.
2d order—	385 " "	70 " " "	19 "

In well developed plants the primary umbels are entirely of hermaphrodite flowers, and umbels of the 2d order are entirely male. Umbels of the 3d order are rare and contain only male flowers. They represent umbellets of secondary umbels. Twenty plants bore 20 umbels of 1st order, 50 of the 2d, and 2 of the 3d. The hermaphrodite flowers are proterandrous.

In regard to visitors, Tiedmannia agrees essentially with Cicuta and Sium, but there seems to be a tendency for hymenoptera to fall off, probably on account of the late blooming. Thus Sium shows 25 more hymenoptera, but only 6 more flies. Cicuta shows 63 more hymenoptera and only 20 more diptera.

Hydrocotyle umbellata, L.—I found only hermaphrodite flowers, which are proterandrous. While the anthers are discharging pollen the styles are bent over upon each other.

The plant was observed at Orlando, Florida, in March, and, although it blooms earlier than Erigenia in Illinois, it shows insects which do not occur when Erigenia is in bloom. It agrees with early species having fully exposed nectar in showing a preponderance of diptera.

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* l. c.

Review of the Umbelliferæ.

In a general way, insects increase in numbers as it becomes warmer, and we may expect to find more species on the later forms.

Flies are common throughout. They show a preponderance in the lists of early species, except those with concealed nectar. They reach their maximum proportion on Heracleum and Eulophus. In Cicuta they decrease on account of increased competition with hymenoptera, and in Eryngium also on account of concealment of nectar. As far as the food of the adults is concerned, the earlier months seem to be much more favorable to flower-flies.

Bees also appear to be equally common throughout, only Zizia and Pastinaca showing more species than Erigenia. The flowers with concealed nectar and those blooming in early spring are most favorable to them.

Other families of hymenoptera show a marked increase in number of species from early spring. A few forms appear as the season advances, and they reach their maximum in July and August. The Eumenidæ and Crabronidæ are the only families in which the increase is not well marked. We can best understand the changes in the lists if we regard the bees and flies as practically stationary, their proportions and their actual numbers in the lists being reduced by the increase in numbers and the competition of the lower hymenoptera.*

The character of the visitors of Umbelliferæ, therefore, must depend upon the insects to which they are exposed, i.e., upon the time of blooming. Indeed, the time of blooming is almost or quite as important as modifications to hide the nectar. If we take three white-flowered forms with exposed nectar, but appearing at different times, we will find the extremes in character of visitors. Thus, Erigenia shows the highest proportion of bees, Eulophus the highest proportion of flies, and Cicuta the highest proportion of lower hymenoptera. Zizia, Polytænia and Eryngium agree in showing a preponderance of hymenoptera over flies as an effect of concealment of honey. Pastinaca, Cicuta and Sium show the same result as an effect of time of blooming. Forms with hidden nectar also show marked contrasts on account of time of blooming. Thus, in the case of Zizia, which blooms in May, one-half of the hymenoptera are bees, while in Eryngium, which has more deeply-seated honey but blooms in July, only one-third of the hymenoptera are bees.

Concealment of nectar, however, accomplishes one important result which cannot be accomplished by change of time of blooming, and that is the simultaneous exclusion of flies and short-tongued hymenoptera. The effect of concealment of nectar can only be ascertained by comparison with a form having free honey, and blooming at the same time as Eryngium with Cicuta.

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* See Table II.

In Erigenia bulbosa, Chærophyllum procumbens and Hydrocotyle umbellata I found only hermaphrodite flowers; all of the other species bear male flowers as well. Male flowers are most abundant in the centre of the umbels, in the centre of the umbellets, and on the side of the umbellets which is nearest the centre of the umbel. It follows that hermaphrodite flowers are most abundant on the outside of the umbels, on the outside of the umbellets, and on the side of the umbellets which is nearest the outside of the umbel. In Sanicula, however, the hermaphrodite flowers are central, and in Zizia the fruitful umbellets commonly have a single, central hermaphrodite flower.

Erigenia, Zizia, Thaspium, Polytænia, Pimpinella, and Sanicula Marilandica, have the styles strongly exserted, and are abundantly visited by insects before the anthers are dehiscent. From a careful examination of the styles in all stages, I am satisfied that they are proterogynous. With the exception of Erigenia, they have the nectar concealed by the incurved petals. In the character of their insect visitors, with the exception of Eryngium, they are the most highly specialized of Umbelliferæ.

In the proterogynous species—Zizia, Thaspium, Polytænia, and Pimpinella—the primary umbel commonly contains only male flowers to supply the first stage of the secondary umbels, and the proportion of hermaphrodite flowers increases in umbels of the 2d and 3d orders. On the other hand, the proterandrous species—Heracleum, Eulophus, Pastinaca, Cicuta, Sium, and Tiedmannia—commonly have the primary umbels entirely of hermaphrodite flowers, and the last umbels entirely male, to supply the pollen for the second stage of the preceding umbels. This difference in behavior goes to support the view that the plants mentioned in the former group are really proterogynous.

In well developed plants the first and last umbels thus tend to specialization; but when the flowers are reduced to a single primary umbel, as in the plants mentioned under Heracleum and Pimpinella, this umbel contains both male and hermaphrodite flowers.

Umbelliferæ.—Table I.

		No. Days.	Dates.	Tenthredinidæ & Parasitica.	Chrysididæ.	Formicidæ & Mutillidæ.	Scoliidæ.	Pompilidæ.	Sphecidæ.	Larridæ.	Bembecidæ.	Nyssonidæ.	Philanthidæ.	Crabronidæ.	Eumenidæ.	Vespidæ.	Andrenidæ.	Apidæ.	Bombylidæ & Conopidæ.	Syrphidæ.	Muscidæ.	Other Diptera.	Coleoptera.	Hemiptera.	Lepidoptera.	Neuroptera.	Total.
1	Erigenia bulbosa	15	Mar. 20–Apr. 21		1												21	6	1	10	17	2	2		2		62
2	Chærophyllum procumbens	3	Apr. 27–29	8													9	3		10	13	2	4	1			50
3	Zizia aurea	6	May 7–26	9	1		1	3						9	9		23	12	1	3	36	8	11	2	3		131
4	Polytænia Nuttallii	4	May 9–26	2			1							3	8	1	9	2		1	10	2	1	1			41
5	Osmorrhiza longistylis	5	May 11–23												2		7	1		6	2	2	1	1			22
6	Sanicula Marilandica	3	May 14–23	1											2		10	1		2	7	4		2			29
7	Heracleum lanatum	7	May 25–Jun. 14	18	1		1	3	3	1				13	8	1	13	5	5	21	50	11	13	2	5		174
8	Pimpinella integerrima	2	May 29–Jun. 2											1			6	3	1	6		2	3		1		23
9	Eulophus Americanus	2	June 8–11	9	2	1		3	2				1	7	3	1	7		1	12	32	7	7	2			97
10	Cryptotænia Canadensis	2	June 15–July 9	5		1		1					1	3	3		11	1	1	8	9	4	10	1			59
11	Pastinaca sativa	26	June 2–July 9	39	3	2	2	10	7	2		1	5	12	12	2	22	8	3	22	56	10	40	6	9	1	275
12	Cicuta maculata	19	July 8 to Aug. 13	21	6	4	7	20	12	12	3	3	5	14	8	7	15	6	4	14	45	9	14	1	8		238
13	Eryngium yuccæfolium	10	July 14–Aug. 8	1		1	6	6	8	3	6		6	4	9	1	14	11	10	11	18	2	8	2	20		147
14	Sium cicutæfolium	20	July 20–Aug. 27	37	3	1	4	8	7	4	1	2	6	10	6	3	9	4	5	11	37	5	19	4	5		191
15	Tiedmannia rigida	7	Aug. 14–Sept. 8	28	4	3	4	6	5	5	1	1	2	7	4	2	7	1	2	6	41	3	16	4	3	1	156
16	Hydrocotyle umbellata (Fla.)	3	Mar. 15–20				1	5		2				1				1		4	18		3				35

Umbelliferæ. – Table II.

	Hymenoptera.	Diptera.	Other Insects.	Bees.	Other Hymenoptera.	Diptera.
WITH EXPOSED NECTAR:						
Erigenia bulbosa	28	30	4	27	1	30
Chærophyllum procumbens	20	25	5	12	8	25
Osmorrhiza longistylis	10	10	2	8	2	10
Heracleum lanatum	67	87	20	18	49	87
Eulophus Americanus	36	52	9	7	29	52
Cryptotænia Canadensis	26	22	11	12	14	22
Pastinaca sativa	127	92	56	30	97	92
Cicuta maculata	143	72	23	21	122	72
Sium cicutæfolium	105	58	28	13	92	58
Tiedmannia rigida	80	52	24	8	72	52
WITH CONCEALED NECTAR:						
Zizia aurea	67	48	16	35	32	48
Polytænia Nuttallii	26	13	2	11	15	13
Sanicula Marilandica	14	13	2	11	3	13
Pimpinella integerrima	10	9	4	9	1	9
Eryngium yuccæfolium	76	41	30	25	51	41

Winter Temperatures.

By Francis E. Nipher.

The temperature of the December just past is above that of any other in fifty-two years. The normal December temperature during that time is 33.5. The monthly means have varied from 23.3 in 1876 to 49.4 during the last year.

For purposes of comparison, we may define a normal December, one which varies less than two degrees from the average of the Decembers of 52 years. A mild December will fall within a range of four degrees just above the normal range. Above the mild Decembers, over a range of four degrees, will be the warm Decembers, and above will lie the very warm months. Similarly below the normal, we have three four-degree belts, which we may define as cool, cold, and very cold months.

Including the month just past, the number of times the month has fallen within these groups since 1837, are given in the following table. There have been two very warm Decembers, five warm, thirteen mild, etc. Similar values for January and February are given in the same table.

	December	January.	February.
Very warm	1	1	0
Warm	5	10	4
Mild	13	11	20
Normal	14	6	10
Cool	13	16	12
Cold	4	6	2
Very cold	2	2	3
	53	52	52

It will be observed that the divergence of these Decembers from the normal is very symmetrical. A probability curve would represent them with precision. January, however, is a month of extremes. There have been only 6 normal Januaries in fifty-two years, while there have been 16 cool, 11 mild, and 10 warm Januaries.

Some years since Dr. Engelmann stated, that, according to past experience, a warm December is likely to be followed by a warm January and February. This seems to have a rational basis, as the earth when kept warm during December is likely to affect the character of the following months.

The following table gives the character of the months following the very warm and warm Decembers, and the final column gives the character of the January and February following, taken as a whole:

	December.	January.	February.	Jan. & Feb.
1877	very warm	mild	mild	mild
1846	warm	cool	normal	normal
1857	"	warm	cold	"
1862	"	"	normal	mild
1875	"	"	mild	warm
1881	"	normal	warm	mild

In two cases of a warm December the remaining portion of the winter was normal, while in four cases it was above normal. Only one out of the twelve winter months which followed warm Decembers was really cold, viz., February, 1858, having a mean of 27.1, or 7°.9 below the average of 52 years.

In case of the 13 mild Decembers, the character of the rest of the winter was

Below normal	5	times,
Above "	6	"
Normal	2	"

The 14 normal Decembers were followed by winter weather:

Above normal	4	times,
Below normal	6	"
Normal	4	"

The 13 cool Decembers were followed by winter weather:

Above normal	4	times,
Below "	5	"
Normal	4	"

In all of these cases, excepting warm and very warm Decembers, the character of that month affords no criterion of the character of the rest of the winter.

Coming now to cold and very cold Decembers, it appears that they have also usually been followed by winter months of normal temperature or above. This is shown in the table below.

	December.	January.	February.	Jan. & Feb.
1838	cold	warm	mild	mild
1845	"	"	cool	"
1859	"	mild	mild	"
1872	very cold	cold	cool	cool
1876	" "	normal	mild	normal
1878	cold	cool	normal	cool

This state of affairs does not seem to rest on any rational basis, and is well calculated to make us look with some distrust on the prediction based upon warm Decembers.

FREDERICK ADOLPHUS WISLIZENUS.

By Dr. G. J. Engelmann.

Dr. Frederick Adolphus Wislizenus was born in May, 1810, at Koenigsee in Schwarzburg-Rudolstadt, one of the most beautiful of the many little German principalities of that time. He was the youngest of three children of a Protestant minister whose ancestors, certainly not of German, probably of Polish origin, are said to have fled from their homes in Bohemia victims of the religious fanaticism which led to the persecution of Huss and his followers.

Wislizenus entered upon the study of medicine at the Universita of Jena in 1828. and later studied at Göttingen and at Würzburg. With many of his fellow-students, he became deeply interested in the patriotic but visionary plans of the Burschenschaft, of which he was a member, and was one of a handful of young enthusiasts who determined to overthrow the monarchial government of Germany, but were speedily overpowered after a first bold stroke in the city of Frankfort. Some were captured; others escaped, and among them young Wislizenus,* who followed his friend and teacher, the great clinician Schoenlein, to Zurich. While here he became interested in the cause of Italy and joined an expedition to aid Mazzini in his struggle against Austrian rule; but again he was forced to return to his studies, well-intentioned Swiss troops disarming the young men before they had succeeded in reaching the border.

Wislizenus graduated in Zurich in 1834, visited the Hospitals of Paris, and then sailed for New York, where he entered upon

* One of his compatriots was Gustavus Koerner, a fellow-student at the University of Jena, who likewise made his escape and fled to the United States, settling in Belleville, Ill., where he rapidly assumed prominence, was elected Lieutenant-Governor of the State, and later accredited as United States Ambassador to Spain. In his work, "The German Element in the United States," Koerner pays a handsome tribute to his friend Wislizenus.

the practice of his profession in 1835. He remained there only two years, actively at work with his pen both as political pamphleteer and poet,* having acquired the language, and familiarized himself somewhat with the country. He set out for the West in 1837, and joined Koerner and others of his fellow-exiles who had found a home in St. Clair county, Ills. Until 1839 he practiced in the small town of Mascoutah, and then, tired of the monotony of country life, came to St. Louis and at once found a long-wished-for opportunity. He volunteered to accompany one of the expeditions of the St. Louis Fur Company for trading with the Indians. With these hardy pioneers he penetrated far into the Northwestern country toward the source of the Green River. in the Wind River Mountains; but, when the traders had exhausted their supplies and turned homeward, Wislizenus, eager to explore this boundless and unknown territory, joined a band of Flathead and Nez-Percés Indians, aud moved on with them, crossing the Rocky Mountains to the high lands of the present Utah, and as far as Fort Hall, then the most southerly trading post of the British. No guide being found willing to take him over the Sierra Nevada to California, he turned back. Crossing the lower Green River and the south fork of the Platte. he followed the Arkansas to the border of Missouri.

Unfortunately he was not able to utilize his opportunities for scientific purposes, as he was without instruments or facilities of any kind, so that his hazardous journey proved little more than a pleasant recreation.

Upon his return to St. Louis in 1840, Dr. Wislizenus resumed the practice of medicine and soon became identified with the varied interests of the rapidly developing city. A Democrat in politics, he took an active part in all that pertained to local affairs, and especially such as concerned the German population.

* He wrote constantly for the German papers of New York from the standpoint of the American citizen, urging his countrymen to identify themselves more thoroughly with the home of their adoption, and throw aside all clanish feeling. But amid his new surroundings he had not forgotten his old home, and with poetical fire he gave vent to his contempt for the petty tyrants of the old world. A number of these verses were publiished during the period of his New York residence, and others appeared now and then at intervals in later years. They are extremely interesting as indicative of the times and not without poetical merit.

He was one of the few regular attendants at the meetings of the Western Academy of Science, and efficiently aided his friend, Dr. Engelmann, in all his efforts in behalf of the new institution. Among the projects in which they were interested, and which failed like others of their premature undertakings, was the establishment of a Botanic Garden. The minutes of the Western Academy bear witness to the difficulties encountered

Dr. Wislizenus soon gained a lucrative practice, and was loved and respected as a physician. But, no sooner did a good opportunity present itself, than he was again in the saddle. Well equipped with instruments for observation and facilities for collecting, he joined a trading expedition to Mexico, which was thoroughly organized and afforded him all the advantages he had so sorely missed on his first trip. In Santa Fé the travellers first heard of the war which had broken out between Mexico and the United States; but Wislizenus managed to secure passes and pushed on to Chihuahua, where he (with other Americans) was seized and imprisoned. Wislizenus was sent to a distant mountain village, where he remained a prisoner during the winter, with ample leisure to study the surrounding country and arrange his notes and collections. The prisoners were finally liberated by the arrival of Col. Doniphan's troops in Chihuahua, in the spring of 1847, and the doctor remained with them in a professional capacity until they were disbanded at New Orleans in the summer of 1847, when he returned to St. Louis.

It was due to the efforts of Senator Thomas H. Benton, who had become acquainted with the enthusiastic young student, that Wislizenus was summoned to Washington and requested, by vote of Congress, to publish the results of his investigations. The "Memoir of a Tour to Northern Mexico in 1846 and 1847, by A. Wislizenus, M.D., Washington, 1848," corrected many erroneous views of the Western country, afforded a fairly accurate knowledge of an entirely new territory along the Rio Grande, and was deemed of such importance that the Senate ordered 5,000 copies for distribution. In this memoir we find the first notes of the country between Santa Fé and the mouth of the Rio Grande, an excellent map of the entire route, as well as a geological sketch and a profile chart of altitudes. The meteorological and astronomical observations were extremely valuable at the time, and the determination of elevations by daily barometric observations, from the borders of Missouri through Northern Mexico to the mouth of the Rio Grande, has required but few alterations since. The measurements made by Wislizenus likewise served to complete the hydrography of Mexico, and the value of this part of the work was acknowledged by Alexander von Humboldt in a very complimentary manner.

Among the trophies of this expedition was a valuable botanical collection containing many new plants which were classified and described by Dr. Engelmann, who commemorated the work of the explorer by giving his name to several of the new species.

While engaged in the publication of his "Memoir" in Washington, Wislizenus met Miss Lucy Crane, sister-in-law of the Hon. Geo. P. Marsh.

After completing his work in the East the doctor returned to St. Louis, where he served with untiring energy and zeal during the terrible epidemic of 1849; but, scarcely had the cholera subsided, when, in 1850, he hastened to Constantinople, where Mr. Marsh was then living with his family as United States Minister to Turkey.

Dr. Wislizenus and Miss Crane were married at the United States Legation in Constantlnople, and, after visiting his old home in Thüringen and the great cities of the old world, with his bride, the doctor returned to the United States. Leaving his young wife with her friends in the East, he sailed for Panama and spent some time on the Pacific coast in search of a more desirable and profitable location; but, dissatisfied with the prospect in California, he returned again to St. Louis in 1852, and here this restless traveller at last permanently settled down to the practice of his profession. He never again left the city unless for brief recreations at his country-seat near Kimmswick, Jefferson Co., Mo., a most attractive spot upon a high bluff commanding a view of the Mississippi River as far as Carondelet to the North, and far away over the prairies of Illinois to the East and South.

Dr. Wislizenus was one of the founders of The St. Louis Academy of Science, and in early years an active worker in, and one of the officers of, The St. Louis Medical Society and The Western Academy. For many years, also, he was President of the German Medical Society of St. Louis. His barometrical observations, and his botanical and mineralogical collections in the South-West, together with his "Memoir," must be considered as valuable contributions to Science. In later years an extensive medical practice absorbed almost his entire time, but did not altogether interfere with his scientific work. and he contributed largely to the proceedings of this association. His meteorological observations, begun in the interest of his friend, Dr. Engelmann, during the latter's absence in Europe in 1858, he continued until his eyesight began to fail. In 1861 he took up the study of atmospheric electricity with his wonted enthusiasm and perseverance, in the belief that this would prove the most important factor in meteorological science. Equipped with the best instruments obtainable at the time, he continued his tedious investigations until he became convinced that they would lead to only negative results — a fact now generally acknowledged. He found that daily variations existed as well as numerous sudden changes, local in character and without positive significance — a result that has not been materially altered by the improved instruments of the day.

With advancing age Dr. Wislizenus withdrew more and more from contact with his fellow-men, and during his last years he led a most secluded life at the home of his son, being closely confined to the house by increasing infirmity and the loss of his eyesight: he was now seen but rarely at the meetings of the Academy, and from the practice of medicine he was forced to retire altogether. After a lingering aud extremely trying illness Dr. Wislizenus died on the 22d September, 1889, in the 80th year of his age, and in accordance with his long expressed wish he was laid to rest on a projecting spur of the forest-clad hills of his country home.

Surface Integrals in Meteorology.

By Francis E. Nipher.

This country is now so well provided with observers of temperature and rainfall that it is easy to draw lines of equal rainfall and temperature with great precision.

Some years since the writer began an examination of the relation between the amount of water falling upon various sections of the Mississippi and its tributaries and the amount of water discharged from that area in the rivers. It was found, for example, that the rainfall in cubic feet upon the state of Missouri during the two years ending in 1888 was exactly equal to the water flowing past St. Louis in the Mississippi river, as determined from the daily gauge readings.

It is evident that a similar integration of rainfall over the United States will be a very stable quantity, and it is a matter of great interest to learn how much this quantity varies from year to year. I have applied this method to the ten-year rain charts of the Signal Service which cover the period ending in 1880. The map areas were determined by the planimeter. The rainfall between the nine-inch line and the ten-inch line was asssumed to be nine and a half inches. The scale of the map was determined by measuring the map areas of a group of states whose areas in square miles may be considered as well known. The amount of water in cubic feet is then easily determined by a summation of such integrals. Where the lines closed upon themselves around maximum or minimum areas, special methods of determining the rainfall to be assigned were used, which it is unnecessary to explain here.

The results for the whole country in cubic miles of water are —

January	96.1
February	94.2
March	114.7
April	119.7
May	126.9
June	146.5
July	138.1
August	121.8
September	102.5
October	90.4
November	100.9
December	105.5
Year	1357.3

The map showing the average rainfall for the year gives by a similar treatment 1406 cubic miles, which differs from the value deduced from the monthly maps by less than two and one half per cent.

This water would fill a ditch half a mile deep and a mile wide, reaching nearly from New York to San Francisco.

The average rainfall per second on the whole country would fill a cubical box whose edges are 187 feet.

According to measurements which I have made on the velocity of falling rain-drops, the average velocity is between 180 to 200 ft. per second. This total rain is therefore eqnal, roughly, to a stream of water 187 ft. square in section delivered upon the earth with the velocity of falling rain-drops.

Similar methods are used in finding average temperatures of a country or a state. Such integrals afford a reliable means of comparison of any monthly values with normal values, and certainly afford the most delicate method of testing any systematic change in the climate of a county or any part thereof.

On the Analysis of the Barium Group.

By C. Luedeking.

The method ordinarily used for examination of the Barium group precipitate, as it is described in Fresenius' Qualitative Analysis, proved itself to be unsatisfactory on several occasions. It occurred that Barium was mistaken for Strontium, and that it was impossible to find the latter at all when these substances were present in small quantities with large quantities of Calcium. After having assured myself of this fact by special experimental investigation, I came to the conclusion that the method is incapable of giving exact results, and that it is possible to overlook quite considerable quantities of Barium and Strontium in working according to it. The thought involuntarily forces itself upon one, that, in view of this fact, it has, no doubt, frequently happened that in mineral analysis these two elements have been overlooked when accompanying Calcium.

For the purpose of more exactly determining the limits of delicacy of the method, I prepared a series of mixtures containing different relative quantities of Barium, Strontium and Calcium chlorides, and examined them according to it. I here give my results in brief.

A solution containing 0.003 gr. of $Ba\ Cl_2$ in 2 c.c. of water, to which 1 c.c. of saturated solution of $Ca\ SO_4$ was added, gave an undoubted reaction for Barium.

A solution containing 0.002 gr. $Ba\ Cl_2$ in 2 c.c. of water gave no immediate precipitate on addition of 1 c.c. of $Ca\ SO_4$ solution ; however, after some time, so that one would have declared that Strontium was present. This is therefore to be regarded a limit of the delicacy of the reaction for Barium, and accordingly we may say, that, if there is less than .1 % of Barium in the solution, it cannot be detected by the $Ca\ SO_4$ test.

At the same time, for the purpose of comparison, I examined into the delicacy of the test for Barium by Chromate of Potassium solution. It was found that 0.001 gr. of $Ba\ Cl_2$, dissolved in 3 c.c. of water, still gave a perceptible precipitate on addition of one drop of a saturated solution of Chromate of Potassium.

We conclude, therefore, that the reaction for Barium with Potassium Chromate is more delicate than with $Ca\ SO_4$, since by the Chromate test we can detect Barium if there is only .03% in solution. According to the usual method of the analysis of the Barium Group the $(NH_4)_2\ CO_3$ precipitate is to be dissolved in H Cl, then evaporated to dryness in order to expel any excess of H Cl. The residue is now dissolved in the least possible amount of $H_2\ O$, and a portion tested with $Ca\ SO_4$. We must, therefore, show the delicacy of the $Ca\ SO_4$ test under other conditions also, that is, in the presence of an excess of Strontium and Calcium.

The following are the results of the experiments made for this end:

To 0.020 gr. $Ba\ Cl_2$ and 0.986 gr. $Ca\ Cl_2$, dissolved in 4 c.c. of water, 1 c.c. of $Ca\ SO_4$ solution was added. There was no precipitate.

To 0.003 gr. $Ba\ Cl_2$ and 0.986 gr. $Ca\ Cl_2$, dissolved in 2 c.c. of water, 3 c.c. of solution of Sodium Acetate with 2 c.c. of a satuturated solution of Potassium Bichromate were added. In the cold there was no precipitate; after boiling, one appeared. Sodium Acetate and Potassium Bichromate were used in order to make the solution strongly acid with Acetic Acid.

To 0.010 gr. $Ba\ Cl_2$ and 0-986 gr. $Ca\ Cl_2$, dissolved in 13 c c. water, 1 c.c, of $Ca\ SO_4$ solution was added. There was no precipitate., which was however the case on the addition of a solution of Bichromate of Potassium.

These experiments show with sufficient clearness that the reaction of Barium with $K_2Cr_2O_7$ is more delicate than with $Ca\ SO_4$ under similar conditions. It also appears that the presence of the large access of Calcium retards the $Ca\ SO_2$ to such a degree that it can no longer be called delicate.

In our experiments we used of Barium Chloride only $\frac{1}{50}$ as much as of Calcium Chloride, or about 2% of it. Further, we see that by the conditions of the experiment 0.02% $Ba\ Cl_2$ may be overlooked in the course of the usual analytical method.

We see, too, that the $K_2\ Cr_2\ O_7$ test is not only more delicate in general, but, what is more important, it is influenced in a much less degree by the presence of an excess of Calcium.

We have, then, sufficient grounds for putting aside the old method of analysis and substituting the Chromate test.

It must also be added that dilution appears to decrease the effect of the Calcium, and therefore that the effect is proportional to the concentration of the solution. But by dilution again the test for small quantities of Barium is rendered impossible, so that we are obliged to work with concentrated solutions. But even in the most dilute solutions the $K_2 Cr_2 O_7$ shows itself far superior to the $Ca SO_4$ test, as is shown by our experiment.

In a similar way the delicacy of $Ca SO_4$ as a reagent for Strontium was tested.

To a solution of 0.001 gr. $Sr Cl_2$ in 2 c.c. water, 1 c.c. of $Ca SO_4$ solution was added and the mixture heated to boiling. There was no immediate precipitate, as the Strontium reaction requires; but, after boiling ¼ of an hour, a very slight precipitate appeared.

A solution of 0.002 gr. of $Sr Cl_2$ in 2 c.c. water, to which 1 c.c. $Ca SO_4$ solution was added, gave on boiling a very fine precipitate, and one could conclude with perfect impartiality that Strontium was present.

These are therefore the limits of the Strontium reaction with $Ca SO_4$ under the most favorable circumstances, and it is possible by that means to detect 0.06 % of Strontium in solution. We conclude, also, that the $Ca SO_4$ test is somewhat more delicate for Strontium than for Barium.

For the same reasons which we gave above in the case of Barium, it was necessary to ascertain the effect of the presence of much Calcium upon the $Ca SO_4$ test for Stronium. This influence—an item of great importance in practical analysis—was proven to be far greater upon Strontium than upon Barium salts.

As a matter of fact, the test by means of $Ca SO_4$ is not in the least delicate, and therefore is perfectly ready to be laid aside.

To 0.020 gr. $Sr Cl_2$ and 0.986 gr. $Ca Cl_2$, dissolved in 4 c.c. water, 1 c.c. of $Ca SO_4$ solution was added. There was no precipitate even after boiling hard for ten minutes. To it was then added 1 c.c. $Ca So_4$ solution and 0.020 gr. $Sr Cl_2$ dissolved in 2 c.c. water. There was still no precipitate even after boiling several minutes. There was added 0.120 gr. $Sr Cl_2$ dissolved in 12 c.c. water, and also 1 c.c. $Ca SO_4$; still no precipitate after hard boiling. There was added in large quantities both $Sr Cl_2$

and $Ca SO_4$ and still it was impossible to get a precipitate even after boiling a long time.

These experiments need no comment. The influence of Calcium salts in hindering the test for Strontium with $Ca SO_4$ is enormous, and it is possible to overlook large quantities of Strontium in testing by the usual analytical method.

In practice, the retarding influence of Strontium upon the Barium test is of minor importance; but, to make the discussion complete, I have examined this case also. In the presence of much $Sr Cl_2$ in solution it is not possible to distinguish as to the absence or presence of small quantities of Barium. It appears as though the Strontium reaction with $Ca SO_4$ more and more likens the Barium reaction in the measure of its concentration. Thus a 30 % $Sr Cl_2$ 6-aq. solution gives with $Ca SO_4$ an immediate precipitate even in the cold; thus giving an appearance which should indicate the presence of Barium.

With more diluted Strontium solutions we get a very different result. In this case the influence of Strontium in solution is exactly similar to the influence of Calcium considered above.

For example, 2 c.c. of a $Sr Cl_2$ 6-aq. solution, with 0.003 gr. $Ba Cl_2$ in solution, gives, on the addition of 1 c.c. $Ca SO_4$, no immediate precipitate; so that it is impossible to detect small quantities of Barium by this means. Indeed, the precipitation is no quicker in this case than with an equally concentrated Strontium solution, under the very same conditions.

Of a very different character is the reaction of a small quantity of Barium in the presence of a large amount of Strontium, with the reagent $K_2 Cr_2O_7$.

2 c.c. of a 6-% $Sr Cl_2$ 6-aq. solution, to which 0.002 gr. $Ba Cl_2$ had been added, was acidified with Acetic acid, and to that was added a few drops of Sodium Acetate solution, and then Potassium acid chromate. On heating, the solution became very distinctly turbid, and in the course of a few minutes a precipitate of $Ba Cr O_4$ had deposited. A Strontium solution of the same strength, under the same treatment, showed not the slightest turbidity. These experiments indicate plainly the delicacy and trustworthiness of the Potassium Chromate.

By our experiments two facts have been proven:

1st. The presence of Calcium and Strontium salts are prejudicial to the Ca SO_4 test for Barium.

2d. The presence of Calcium affects even in a greater degree the delicacy of the Ca SO_4 test for Strontium.

In the light of these facts we are bound to seek for a more exact method of analysis. From these same experiments such a method, I believe, has been suggested.

This method rests, in the first place, upon the fact, that, even in the presence of large quantities of Calcium and Strontium, Potassium Chromate will precipitate Barium on boiling if the solution has been acidified with Acetic Acid. Eveh small traces of Barium give this reaction, and there is no danger of confusing it with either Calcium or Strontium.

In all cases saturated solutions of K_2 Cr O_4, or of K_2 Cr_2O_7, must be used.

After the separation of the previous groups, precipitate the Barium group with $(NH_4)_2CO_3$, heat to boiling and filter; wash carefully the precipitate and dissolve in the least possible quantity of Acetic Acid. Add to this solution an excess of saturated K_3 CrO_4. Heat for several minutes to boiling. If there is a turbidity or precipitate, the presence of Barium is proven. Precipitate by this means all the Barium; filter. Make the filtrate alkaline with Ammonia and add $(NH_4)_2CO_3$ in excess. A precipitate formed may be Strontium or Calcium, or Strontium and Calcium. It is filtered, washed, dissolved in the smallest possible quantity of H Cl, and tested for Strontium by means of the spectroscope. Then H_2 S o_4 is added to the solution, heated, the precipitate filtered off, and in the filtrate Calcium is tested for in the ordinary way by means of Ammonium Oxalate.

This method is capable of quick execution and certain in its results, which is not the case with the old method.

One other circumstance is to be noticed, i.e. large quantities of Barium and Strontium do not hinder the detection of small quantities of Calcium.

Now this modified method has the disadvantage that for its execution it is necessary to use the spectroscope, and consequently it is impossible to judge as certainly concerning the quantity of Strontium present as in case of a precipitate test. The author sought in vain for a long time to discover such a method.

Strontium salts, in the absence of Calcium salts, are precipitated even in traces by Chromate of Potassium in ammoniacal solution. However, the detection of Strontium in this way suffers from the same inconvenience as the $Ca\,SO_4$ test for Strontium; it is not at all delicate in the presence of Calcium salts.

Further fractional precipitation by means of $H_2\,SO_4$ was tried in the expectation that Strontium salts would be precipitated first in order. This was, however, found not to be the case.

Further experiments for the purpose of finding, if possible, a precipitation method are at present in course, and I hope soon to be able to make communication of my results.

CONTRIBUTIONS FROM THE SHAW SCHOOL OF BOTANY.

No. 7.

A Catalogue of the Anthophyta and Pteridophyta of Ames, Iowa.

By A. S. Hitchcock.

Read Oct. 20, 1890.

INTRODUCTION.

The following list is based upon collections made during the years 1882 to 1889. All the names are founded upon specimens in my herbarium unless otherwise stated. A few specimens are in the herbarium of the Agricultural College at Ames, while a very few names, indicated in each instance, are admitted on good authority without specimens.

Considerable care has been taken in the identification of species, and in doubtful cases the name has been omitted from the list. As *Aster*, *Salix*, *Potomogeton*, *Carex*, and *Equisetum* have not been thoroughly worked up, there will doubtless be many additions in these genera. In order that the names in difficult genera should be authentic, the specimens have been submitted to specialists, to whom I wish to acknowledge my obligations. Many grasses were sent to Dr. Vasey and Prof. Scribner; carices to Prof. L. H. Bailey; *Cyperus* and *Eleocharis* to Dr. Britton; *Euphorbia* to Dr. Millspaugh; *Umbelliferæ* to Dr. Coulter; *Fraxinus* and *Cratægus* to Prof. Sargent; roses to Dr. Best; miscellaneous specimens to Dr. Watson.

Gray's Manual, sixth edition, has been followed for the names and sequence of the orders, and, in most cases, of the genera. The principle of using the earliest specific name has been adhered to as closely as possible; that is, commencing with Linnæus' Species Plantarum, in 1753, the earliest specific name, in whatever genus first used, is retained, provided it does not result in two species of the same name in one genus, or in the specific name being identical with, or too nearly resembling, that of the genus. The same principle has been applied to varietal names. Date of publication as indicated by the title-page or collateral evidence, and lineal sequence in a given publication, have been taken as the grounds for deciding priority. In the absence of some works, recourse has been had to dated lists in Pritzel, Thesaurus; DC. Syst.; Don, Mill. Dict.; Torr. Fl. N. Y., etc.

The question of identity and synonymy has been a difficult one. For this I have depended upon the standard authorities, as I have been able to refer to the specimens in but few cases. I have used the earliest name concerning which there seems to be no reasonable doubt, while those which were less certain have not been taken up. Consequently there are names which may give way to earlier ones when investigated by those more competent for the task; but the bibliography of each name has been worked out as thoroughly as my resources would permit. In this work I have been very materially aided by Dr. Watson, Dr. Britton, Prof. Scribner, and Mr. D. G. Fairchild.

Following each name is the place and date of publication, so far as this could be ascertained. To avoid repetition, a dated list of the principal works quoted has been appended to the catalogue. Where a species was originally placed under a different genus from the one accepted, the author of the specific name is quoted in parenthesis, followed by the author of the accepted combination. A name has been considered published when, in connection with the generic and specific name, there is sufficient description to identify the species. The date of publication has been taken to be that of issue. For example, a description of *Cypripedium spectabile*, Salisbury, was read before the Linnæan Society in 1788, but was not published until 1791, subsequent to *C. reginæ*, Walt., and *C. album*, Ait. When an author transfers a species from one genus to another, but does not make the combination under the new genus, he is nevertheless quoted for that combination if he singles out the species. For example, Robert Brown in his Prodromus Floræ Novæ Hollandiæ establishes the genus *Eleocharis*. In a note he says, "genus naturale efformat cui .... pertinent Scirpus palustris, L., ... et acicularis, L." I have quoted Brown as the author of *E. palus-*

tris and *E. acicularis*, though these combinations first formally appeared in Roemer and Schultes' Systema Vegetabilium.

Following the accepted names in the list, is the synonymy: first, the original combination; second, the combination used in the last edition of Gray's Manual; third, any others having a critical bearing on the nomenclature. Following this, is the habitat and frequency of occurrence. The latter is indicated by the following terms, in the order given: common, abundant, frequent, not uncommon, infrequent, scarce, rare. When the species is rare, or known only for a few stations, these are indicated. Names of indigenous and well established introduced species are in small capitals; those of species which do not appear to be established, and hence are not really a part of the flora, are placed in lower-case type; but those which were formerly abundant, and have become scarce, are retained in small capitals. No distinction has been made in the list between well marked varieties and forms which have received varietal names. As the species have been arranged under the genus on an equal footing, the same has been done with the varieties.

Notes have been frequently introduced in order to call attention to difficult points, and that errors may be the more easily located. An attempt has also been made to discriminate between closely allied species.

In conclusion, I wish to thank those botanists whom I have mentioned above, and also Dr. Trelease, who has given me valuable advice throughout the work; Prof. L. H. Pammel, to whom the inception of the work was due, for notes and specimens; Mr. Sirrene, for specimens collected during 1890,—and last, but by no means least, Mr. H. J. Webber, who has kindly consented to undertake, in my absence, the arduous task of proof-reading.

SCOPE OF THE FLORA.

The region included in this catalogue is essentially the vicinity of the Agricultural College at Ames. Quite thorough explorations have been made within a radius of three or four miles about this point. From four to nine miles they have been confined to certain directions; viz., along the railroad from Ames to Gilbert, and from Ames to Nevada; southwest to the "Big prairie," and southeast to a small "lake" about ten miles from the College. A few plants have been included from the Des Moines river west of Boone, eighteen miles distant: several have also been included from Cairo lake and vicinity, about twenty-two miles away. But in all cases it is so stated if the plant has been found only beyond the three-mile circle.

The topography of the region presents little diversity. We have: *prairie*, the treeless, grassy land, which has not been brought under cultivation. This is fast disappearing, and in a very few years none will be found except along the roadsides and railways. A lrage tract known as the "Big prairie" lies about six miles southwest of the College, just across the Boone county line. Formerly this was a good collecting ground, especially on account of the ponds it contained, but its distinctive characters have been lost as a result of close grazing and a succession of dry seasons. I have designated as "low" or "wet prairie" depressions which are wet most of the season, but not sufficiently so to be called ponds. In such places may be found *Caltha palustris* and *Cardamine bulbosa*.

Then there are *sterile hills*, where the soil is usually stony. Such is the land northeast of the College beyond Squaw creek. The hills forming the east side of the valley of Skunk river, from the northwest school south to the "lake," are very sandy. Here are found *Cyperus filiculmis* and *Œnothera rhombipetala*.

The wooded portions are mostly confined to the proximity of the streams, five of which are included in our region. The *upland woods* are found along the bluffy side of the streams, or, in case of the smaller streams, all is upland. Here are found *Quercus alba*, *Hicoria ovata*, etc. Frequently near by, or often at considerable distance, occur thickets or copses composed of *Prunus Americana*, *Pirus Americana*, *Corylus Americana*, etc. The *lowland woods* are found on the lower and moister portions. Here thrive *Platanus*, *Juglans*, and *Ulmus*. *Bottom land* is the low land along streams, especially the treeless portion. It is subject to overflow in the spring, and later is covered with a rank growth of *Vernonia fasciculata*, *Spartina*, Verbenas, etc. The portion in the angle formed by the junction of Squaw creek and Skunk river is called "The forks."

There yet remains to be spoken of, the habitat of water-plants. A few can be found in the streams, but the greater part are only found in still or slow-flowing water. The nearest lakes are Cairo lake and the walled lakes of Hamilton county. Besides these there are ponds, of which there are two kinds: First, those which have muddy banks and water, and which are often bayous from the streams; in these scarcely any vegetation grows. The second class is found in depressions in the prairie. The vegetation is very dense, and the bottom is of peat. Here will be found water-lilies, pond-weeds, and *Utricularia*. Formerly these prairie ponds were very numerous, but the extensive system of drainage employed of late years, and the series of droughts from 1884 to 1887, have caused them to almost disappear. For this reason many water-plants, which were abundant a few years ago, have been marked in the catalogue as "becoming rare." During the summer of 1889 I was unable to find a single specimen of *Castalia tuberosa*, *Utricularia vulgaris*, *Pontederia cordata*, and a number of other aquatics, though I collected them frequently five or six years ago It is for this reason, chiefly, that plants from Cairo lake are included, as the excursion was made for water-plants.

On the other hand, introduced species become established in our flora, and may soon become a constituent part. *Lactuca Scariola* is an example. Within a few years this species has increased to a marked extent. *Solanum rostratum*, now common in Southwestern Iowa, will undoubtedly reach Story county in a few years.

It is hoped that the following catalogue may be of value as a record useful in studying the changes in the flora of which it treats.

CATALOGUE.

RANUNCULACEÆ.

CLEMATIS VIRGINIANA, L. Amoen. iv. 1760.

Thickets and banks; frequent.

C. PITCHERI, Torr. & Gray, Fl. i. p. 10.

River banks; frequent.

ANEMONE PATENS, L., var. HIRSUTISSIMA, (Pursh).—*Clematis hirsutissima*, Pursh, Fl.—*A. patens*, L., var. *Nuttalliana*, Gray, Man. 5th ed.

Prairie: rare.

Flowering in early spring. It has been collected about two miles southeast of the College.

A. CAROLINIANA, Walt. Fl.

Dry hills; infrequent.

Along the ridge east of the barns, and elsewhere.

Dr. Watson writes that, according to Dr. Gray, our plant is distinct from the South American *A. decapetala*, L., which extends as far north as Arkansas and Texas.

A. CYLINDRICA, Gray, Ann. N. Y. Lyc. iii. p. 221.

Dry woods; frequent.

A. VIRGINIANA, L. Spec.

Dry woods and banks; frequent.

A. PENNSYLVANICA, L. Mant. ii. p. 247.

Moist prairies near sloughs; abundant.

Dr. Watson writes that *A. dichotoma*, L., is a Siberian plant.

I have not access to *A. Canadensis*, L. Syst. 12th ed. 3d appx. 1768. It may be that this name should be used.

A. NEMOROSA, L. Spec.

Rich upland woods; abundant.

Plentiful in early spring around cemetery.

A. HEPATICA, L., var. ACUTA, (Pursh).—*Hepatica triloba*, Chaix, var. *acuta*. Pursh, Fl.—*H. acutiloba*. DC. Prod. i.—*Anemone acutiloba*, Lawson. Ranunc. 1870.

Rich upland woods; abundant.

The first flower to appear in the spring, preferring northern slopes.

Watson's Index cites for *Anemone Hepatica*, var. *acuta*, Bigel. Fl. Bost. p. 135; which is evidently an error as this name does not appear. The Index also cites *Hepatica triloba*, var. *acuta*, Bigel. Fl. Bost. 2d ed. p. 222. What is really said is, '*Hepatica triloba*, β. Lobes acute." In Hooker, Fl. Bor.-Am. i. p. 18, is, "*H. triloba*, β. foliorum segmentis acutis " with synonym, "*Anemone triloba*, var. β. *acuta*, Bigel. Fl. Bost. ed. 2, p. 222," a combination which Bigelow does not use.

ANEMONELLA THALICTROIDES, (L.) Spach, Hist. Veg. vii. 1839.—*Anemone thalictroides*, L. Spec.

Rich upland woods; abundant.

THALICTRUM DIOICUM, L. Spec.

Rich upland woods; not uncommon.

T. PURPURASCENS, L. Spec.

Low prairie and rocky woods; abundant.

RANUNCULUS CYMBALARIA, Pursh, Fl.

Dry hills; scarce.

Northeast corner of "Big Prairie."

R. LACUSTRIS, Beck & Tracy, in Eat. Man. 3d ed. 1822.—*R. multifidus*, Pursh, Fl.

Ponds; becoming rare.

When a pond containing it is drained, the plant persists for a year or two, but the finely divided leaves are replaced by lobed or incised forms.

For remarks on the nomenclature of this species, see Greene, Pittonia, ii. 8; Eat. Man. 5th ed. p. 359, note 3; DC. Syst. i. 270 & 303; Prod. i. 34 & 43. DeCandolle places *R. multifidus*, Forsk. Fl. Æg. 1775, under *R. Forskæhlii*, among "Ranunculi non satis noti."

R. ABORTIVUS, L. Spec.

Low woods; common.

R. SEPTENTRIONALIS, Poir. Dict. vi. p. 125.

Moist prairies and meadows; common.

R. Pennsylvanicus, L. f. Suppl. 1781.

Wet ground; south shore of Cairo lake.

R. acris, L. Spec.

Waste places. A small patch has persisted for several years near the northwest corner of the Chemical Laboratory, probably introduced with packing material, but it has shown no tendency to spread.

ISOPYRUM BITERNATUM, (Raf.) Torr. & Gray, Fl. i. p. 660.—*Enemion biternatum*, Raf. Journ. Phys. ii. 1820.

Low woods; common.

CALTHA PALUSTRIS, L. Spec.

Swamps; frequent.

Bog near pump-house, and elsewhere.

AQUILEGIA CANADENSIS, L. Spec.

Rocky woods; frequent.

DELPHINIUM AZUREUM, Michx. Fl.

Prairie; not uncommon.

Quite abundant along railroad west of lower gate.

Dr. Watson writes that *D. Carolinianum*, Walt. Fl. is doubtful.

ACTÆA SPICATA, L., var. RUBRA, Ait. Hort. Kew.

Rich woods; infrequent.

Woods near cemetery, Onion creek, Skunk river, and elsewhere. The red berries ripen in early August.

A. ALBA, (L.) Bigel. in Eat. Man. 4th ed.—*A. spicata*, L., var. *alba*, L. Spec.

Rich woods; scarce.

Onion creek, growing with the preceding which it much resembles, but its white berries ripen later.

MENISPERMACEÆ.

MENISPERMUM CANADENSE, L. Spec.

Low woods; frequent, but rare in fruit.

BERBERIDACEÆ.

CAULOPHYLLUM THALICTROIDES (L.) Michx. Fl.—*Leontice thalictroides*. L. Spec.

Rich woods; infrequent.

It has been suggested that *Leontopetalon thalictroides*, Hill, Syst. Veg. xvi. p. 26, be taken up, but I have not been able to satisfy myself that this should be done. The above work gives under the genus *Leontopetalon* the following species: 1. *Leontice crysogonum*: 2. *Leontice Leontopetalum*: 3. *Leontopetalon thalictroides*; 4. *Leontice Leontopetaloides*. These are the four species that are included by Linnæus in his genus *Leontice*.

PODOPHYLLUM PELTATUM, L. Spec.

Rich woods; frequent.

*NYMPHÆACEÆ.**

BRASENIA NYMPHOIDES, (Thunb.) Baill. Hist. Pl. iii. p. 82, 1872. —*Menyanthes nymphoides*, Thunb. Fl. Jap. 1784.

Ponds; rare.

Along railroad a few miles northwest of Ames.

CASTALIA TUBEROSA, (Paine) Greene, Torr. Bull. xv. 1888.—*Nymphæa tuberosa*, Paine, Cat. Pl. Oneida Co. 1865.—*Nymphæa reniformis*, DC. Syst. ii. (?)

Ponds; becoming rare.

In the immediate vicinity of the College there is no suitable habitat, but it occurs frequently in the prairie ponds of the Big prairie and elsewhere.

If *Nymphæa tuberosa*, Paine, and *N. reniformis* are the same, as indicated in Gray's Manual, 6th ed., our plant becomes *Castalia reniformis* (DC.); but there seems to be much doubt as to the identity of DeCandolle's plant.

NYMPHÆA ADVENA, Solander, in Ait. Hort. Kew.—*Nuphar advena*, Ait. f. Hort. Kew.

Ponds and slow streams; infrequent.

In the vicinity of Gilbert and Story City.

PAPAVERACEÆ.

SANGUINARIA CANADENSIS, L. Spec.

Rich woods; not uncommon.

FUMARIACEÆ.

DICLYTRA CUCULLARIA, (L.) DC. Syst. ii.—*Fumaria Cucullaria*, L. Spec.

Rich woods; abundant.

The original spelling of the genus has been retained, since the evidence seems to show that Borckhausen intended the word to be *Diclytra*. If the error be purely typographical it should be corrected. I have not access to Borckhausen's paper (Römer, Archiv. f. d. Bot. i. 2, p. 46), but Bernhardi quotes from this paper (Linnæa xii. p. 668, 1838), "Diclytra nenne ich (Borckhausen) sie (die Gattung) von δις, zwei, und κλυτρον, Sporn, weil sich die Blume so deutlich durch ihre zwei Sporne auszeichnet."

Prof. Trelease suggests that the error may have arisen in a transfer of *kentron* from the original script into the Greek letters. The *e*, being made too high, became an *l*, and then the *n* was read as *u*, making *klutron*.

* For valuable notes on this Order, see Lawson, *Nymphæaceæ*.

CRUCIFERÆ.

DENTARIA LACINIATA, Muhl. in Willd. Spec. iii.

Rich woods; not uncommon.

Most abundant along Skunk river.

If *Dentaria* is referred to *Cardamine*, this becomes *Cardamine laciniata* (Muhl.) Wood, Bot. & Fl. 1871.

CARDAMINE BULBOSA, (Schreb.) B. S. P. Cat.—*Arabis bulbosa*, Schreb. in Muhl. Ind. Fl. Lanc. 1793.

Springs and ditches; frequent.

C. FLEXUOSA, With. Bot. Arr. Brit. Pl. 3d ed. 1796.—*C. hirsuta*, L., var. *sylvatica*, Gray, Man. 5th ed.

Springs and bogs on wooded hillsides; infrequent.

Spring on bank of Squaw creek north of the College, and elsewhere.

Comparison with European specimens shows that our plant is this rather than *C. hirsuta*, L. For notes see Britton, Contr. Herb. Columb. Col. 13, (Trans. N. Y. Acad. Sci. ix. 1889).

ARABIS HIRSUTA, (L.) Scop. Carn. 2d ed. 1772.—*Turritis hirsuta*, L. Spec.

Rocky woods; infrequent.

Skunk river, northeast of Ames. An Ames specimen in the I. A. C. herbarium, labelled *A. lævigata*, belongs here.

A. CANADENSIS, L. Spec.

Rocky woods; infrequent.

Hoggatt's woods; Skunk river.

A. DENTATA, Torr. & Gray, Fl. i. p. 80.—*Sisymbrium dentatum*, Short. Pl. Ky. 3d suppl. 1837 (name only).

Low ground; scarce.

Squaw creek north of College.

DRABA CAROLINIANA, Walt. Fl.

Sandy places; infrequent.

In the gravel near Prof. Budd's house; north of the barns; and elsewhere. The flowering season is short and the pods mature quickly, hence it often escapes the collector.

Alyssum calycinum, L. Spec.

"Ames–Bessey." Specimen in I. A. C. herbarium.

Camelina sativa, (L.) Crantz, Stirp. Austr. i. 1762.—*Myagrum sativum*, L. Spec.

Waste places; scarce. Occasionally occurs along the railroad.

Nasturtium officinale, R. Br. in Ait. f. Hort. Kew.—*Sisymbrium Nasturtium*, L. Spec.

A few specimens found in 1883 in Hoggatt's woods, about 20 rods north of the slaughter-house.

N. sessiliflorum, Nutt. in Torr. & Gray Fl. i. p. 73.

Wet places; rare.

Near iron bridge four miles southeast of Ames. Common in the eastern part of the State.

N. PALUSTRE, (Leys.) DC. Syst. ii. — *Sisymbrium palustre*, Leys. Fl. Hal. 1761.

Wet ground; common.

As a synonym of *N. palustre*, Watson's Index gives *Sisymbrium palustre*, L. The New York Catalogue gives *Nasturtium palustre*, (*L.*) DC. But I have been unable to find *Sisymbrium palustre* in any of Linnæus' works, so I have followed the synonymy given in DC. Syst.

N. Armoracia, (L.) Fries. Fl. Scan. 1835. — *Cochlearia Armoracia*, L. Spec.

Escaped from gardens into wet places.

BARBAREA VULGARIS, R. Br. in Ait. Hort. Kew.—*Erysimum Barbarea*. L. Spec.

Grain fields; infrequent.

Hesperis matronalis, L. Spec.

Occasionally spontaneous around gardens; a few plants found in the lower part of "The forks."

ERYSIMUM CHEIRANTHOIDES, L. Spec.

Woods; common.

SISYMBRIUM CANESCENS, Nutt. Gen.

Rocky places, infrequent.

Along railroad south of Ames, and elsewhere.

S. pinnatum, (Walt.) Greene, Bull. Calif. Acad. ii., is invalidated by *S. pinnatum*, Barneoud in Gay, Fl. Chili.

S. OFFICINALE. (L.) Scop. Carn. 2d ed. ii. 1772. — *Erysimum officinale*. L. Spec.

Roadsides and waste places; common.

THELYPODIUM PINNATIFIDUM, (Mich.) Wats. in King's Rep. v. 1871.—*Hesperis pinnatifidum*. Mich. Fl.

Low woods; frequent.

BRASSICA SINAPISTRUM, Boiss. Voy. Esp. p. 39, 1839-1845.

Fields and waste places; common.

Specimens with sparsely hirsute pods were collected three miles east of Ames.

B. alba, (L.) Boiss. Voy. Esp. p. 39.—*Sinapis alba*, L. Spec.

A specimen was collected along the railroad, between Ames and the College, by Mr. Corbett, and it has been reported by others.

By the accidental omission of the authority in the 5th and 6th editions of the Manual, this would appear to be one of Dr. Gray's species.

B. NIGRA, (L.) Koch in Roehl, Deutsch. Fl. 3d ed. iv. 1833.—*Sinapis nigra*, L. Spec.

Waste places; common.

CAPSELLA BURSA-PASTORIS, (L.) Moench, Meth. 1794. — *Thlaspi Bursa-pastoris*. L. Spec.

Gardens and waste places; common.

LEPIDIUM VIRGINICUM, L. Spec.

Woods and waste places; common.

Plant more leafy, usually less branched, pedicels rather longer and pods somewhat larger than in the next; leaves cut-serrate; petals usually present; cotyledons accumbent. Prefers shady or moist places.

L. INTERMEDIUM, Gray, Pl. Wright. ii. 1853.

Dry or sterile soil; common.

Plant bushy-branched, with nearly entire linear leaves: petals usually minute or absent; cotyledons incumbent. To determine this last and decisive distinction, examine the seed, or, much better, a cross-section, with a good hand-lens or compound microscope.

Raphanus sativus, L. Spec.

Often persists for a year or two in neglected gardens.

CAPPARIDACEÆ.

POLANISIA GRAVEOLENS, Raf. Am. Jour. Sci. I. i. 1819.

Sand or gravel; abundant.

CISTACEÆ.

HELIANTHEMUM MAJUS, (L.) B. S. P. Cat.—*Lechea major*, L. Amœn. iii. 1756.

Dry hills; infrequent.

Northeast of College beyond Squaw creek: sand-hills near Enterprise School.

"Lechea minor."

"Ames–Bessey. 1876." Specimen in I. A. C. herbarium.

VIOLACEÆ.

VIOLA PEDATA, L. Spec.

Prairie and open woods, frequent.

V. PINNATIFIDA, Don, Mill. Dict. i. 1831.

Prairie; not uncommon.

V. PALMATA, L. Spec.

Low ground; not uncommon.

Var. OBLIQUA, (Hill)—*V. obliqua*, Hort. Kew. 1768.—*V. palmata*, L., var. *cucullata*, Gray, Bot. Gaz. 1886.

Low ground; common.

The leaves vary from reniform to narrowly hastate, and from glabrous to downy-pubescent. All the Ames specimens in the I. A. C. herbarium labelled *V. sagittata*, Ait., belong here. The latter is frequent in the eastern part of the State; but I have not seen it within our limits.

V. PUBESCENS, Ait. Hort. Kew.

Low woods; abundant.

CARYOPHYLLACEÆ.

Saponaria officinalis, L. Spec.

Escaped from gardens in many places.

S. Vaccaria, L. Spec.

Waste places; rare.

Specimens occasionally appear along the railroad between the College and Ames.

SILENE STELLATA, (L.) Ait. Hort. Kew.—*Cucubalus stellatus*, L. Spec.

Upland woods: common.

S. NIVEA, DC. Prod. i.

Low woods; infrequent.

DeCandolle cites "Mühlenb. Catal.," but does not adopt his name.—*S. alba.*

S. ANTIRRHINA, L. Spec.
Gravelly soil; infrequent.

LYCHNIS Githago, (L.) Lam. Dict. iii. p. 643.—*Agrostemma Githago*, L. Spec.
Fields and waste places; scarce.

Stellaria media, (L.) Vill. Delph. iii. 1785.—*Alsine media*, L. Spec.
Damp, shady places; scarce.
Quite abundant in east end of flower garden.
Smith, Engl. Bot. 1790–1814, is given in many places as the authority for *S. media*.

S. LONGIFOLIA, Muhl. in Willd. Enum.
Low, grassy places; not uncommon.

PORTULACACEÆ.

PORTULACA OLERACEA, L. Spec.
Cultivated ground and waste places; very common.

CLAYTONIA VIRGINICA, L. Spec.
Low woods; abundant.

HYPERICACEÆ.

HYPERICUM ASCYRON, L. Spec. 2d ed.
Moist places in woods; scarce.
Hoggatt's woods near bridge; Onion creek; woods south of College.

H. MACULATUM, Walt. Fl.
Wet places; rare.
Near mouth of Onion creek.

H. CANADENSE, L., var. MAJUS, Gray, Man. 5th ed.
Sloughs; not uncommon.

MALVACEÆ.

MALVA ROTUNDIFOLIA, L. Spec.
Yards and roadsides; infrequent.
Quite abundant east of Skunk river.

M. sylvestris, L. Spec.
One specimen found along roadside one mile south of College.

ABUTILON AVICENNÆ, Gaertn. Fr. ii. 1791, p. 251.—*Sida Abutilon*, L. Spec.
Waste places; infrequent.

Hibiscus Trionum, L. Spec.
Around flower gardens occasionally.

TILIACEÆ.

TILIA AMERICANA, L. Spec.
Woods; frequent.
Prefers clay bluffs.

LINACEÆ.

LINUM SULCATUM, Riddell, Cat. Pl. Ohio, suppl. 1836.
Dry hills; frequent.

Linum usitatissimum, L. Spec.
Escaped from cultivation; frequent.

GERANIACEÆ.

Geranium maculatum, L. Spec.
Upland woods; abundant.

Oxalis violacea, L. Spec.
Rocky places and cultivated ground; frequent.

O. corniculata, L. Spec.
Woods and pastures; common.
Var. **stricta**, (L.) Sav. in Lam. Dict. iv.—*O. stricta*, L. Spec.
Woods and pastures; common.

Impatiens aurea, Muhl. Cat.—*I pallida*, Nutt. Gen.
Low places in woods; abundant.

I. biflora, Walt. Fl.—*I. fulva*, Nutt. Gen.
Low woods; frequent.

RUTACEÆ.

Xanthoxylum Americanum, Mill. Dict.
Low woods; abundant.

CELASTRACEÆ.

Celastrus scandens, L. Spec.
Thickets and woody bluffs; not uncommon.
Frequent along clay bluffs of Skunk river.

Euonymus atropurpureus, Jacq. Hort. Vind. ii. 1772.
Low woods; not uncommon.

RHAMNACEÆ.

Ceanothus Americanus, L. Spec.
Prairie and open woods; abundant.

C. ovatus, Desf., var. **pubescens**, Torr. & Gray, Fl. i.
Dry hills; scarce.
Northeast of the College, beyond Squaw creek. Fruit matures earlier than in the above.

VITACEÆ.

Vitis riparia, Michx. Fl.
Woods and thickets, both upland and lowland; common.

Ampelopsis quinquefolia, (L.) Michx. Fl.—*Hedera quinquefolia*, L. Spec.—*Vitis quinquefolia*, Lam. Ill. ii.
Lowland woods; abundant.

SAPINDACEÆ.

Æsculus glabra, Willd. Enum.
Des Moines river at Boone (Prof. Budd).

ACER SACCHARUM, Marsh., var. NIGRUM, (Michx. f.) Britton, Trans. N. Y. Acad. Sci. ix 1889.—*A. nigrum.* Michx. f. Arb. Amer. ii. 1810.—*A. saccharinum.* Wang., var. *nigrum.* Torr. & Gray, Fl. i. p. 248. Upland woods; frequent.

A. SACCHARINUM, L. Spec.—*A. dasycarpum*, Ehrh. Beitr. iv. 1789. Low woods; common.

NEGUNDO ACEROIDES, Moench, Meth. 1794.—*Acer Negundo*, L. Spec.

Low woods; abundant.

STAPHYLEA TRIFOLIA, L. Spec.

Moist woods; not uncommon.

ANACARDIACEÆ.

RHUS GLABRA, L. Spec.

Open upland woods, especially along the borders; abundant.

R. RADICANS, L. Spec.—*R. Toxicodendron*, L. Spec.

Two species, *R. raidcans* and *R. Toxicodendron*, were recognized in the Species Plantarum. These are now quite generally considered as but forms of one species, which should take the name having priority of position. Engler (Anacard. in DC. Mon. Phan. iv. 1883) uses *R. Toxicodendron*, L. emend, Torr. & Gray, which includes four subspecies. The first is the only one with which we are concerned: α. *vulgaris*, Pursh, Fl. Under this two forms are recognized—1. *radicans* (*R. radicans*, L.); 2. *volubilis*, DC. Prod. ii. (*R. Toxicodendron*, L.)

We have both forms: 1. climbing high on trunks by rootlets, leaves usually large and entire or sparingly dentate; frequent on bottom-land. 2. Low, erect, or twining, leaves smaller and usually deeply notched; found on drier soil, fence rows, etc. But the low form occasionally has entire leaves, and the rooting form dentate leaves. If the latter form is kept as a variety it is *R. radicans*, L., var. *Toxicodendron*. Pers. Syn. i.

POLYGALACEÆ.

POLYGALA SENEGA, L. Spec.

Rich upland woods; frequent.

P. INCARNATA, L. Spec.

Moist prairie; infrequent.

P. SANGUINEA, L. Spec.

Along sloughs; frequent.

P. VERTICILLATA, L. Spec.

Prairie and open woods; infrequent.

LEGUMINOSÆ.

BAPTISIA LEUCOPHÆA, Nutt. Gen.

Prairie; not uncommon.

B. LEUCANTHA, Torr. & Gray, Fl. i. p. 385.

Low ground; frequent.

This appears first as *Podalyria alba*, Sims, Bot. Mag. 1809. *Baptisia*, Vent. was separated in 1808. Our plant loses its birthright in the specific name *alba* by being transferred to *Baptisia* too late (*B. alba*, Hook. Fl. Bor.-Am.), there being already *B. alba*, R. Br. 1810.

Trifolium arvense, L. Spec.

"Ames, 1871, Bessey." One specimen in I. A. C. herbarium.

T. PRATENSE, L. Spec.
Meadows and pastures: common.

T. REPENS, L. Spec.
Meadows and open woods; common.

T. agrarium, L. Spec.
Several specimens collected along the railroad two miles east of Ames in 1886.

T. procumbens, L. Spec.
Meadows and pastures: infrequent.
College campus; Union creek; Skunk river northeast of Ames.

MELILOTUS OFFICINALIS, (L.) Willd. Enum. — *Trifolium Melilotus officinalis*, L. Spec.
Roadsides and waste places: infrequent.
Streets of Ames, three miles north of College, and elsewhere. Pods plump and smooth.

M. ALBA, Lam. Dict. iv. p. 63.
Roadsides and waste places: infrequent.
Abundant along road two miles west of College.

Medicago sativa, L. Spec.
Sparingly escaped along roadsides.

M. lupulina, L. Spec.
Occasionally found in waste places.

PSORALEA ARGOPHYLLA, Pursh, Fl.
Prairie; abundant.

AMORPHA CANESCENS, Pursh, Fl.
Prairie; common.
The name first appears in Fraser's Catalogue, which is a seedsman's catalogue and contains no description of it. Pursh uses the same name and publihes a description, but does not quote Fras. Cat., although he does quote it for other species. Nuttall in his Genera publishes a description, and quotes "T. N. Fras. Cat." He prefixes the ★, which indicates *n. sp.* The remark is made that Pursh saw a flowering specimen only, in Nuttall's herbarium.

A. FRUTICOSA, L. Spec.
Sloughs and river banks; frequent.

Dalea alopecuroides, Willd. Spec. iii.
Infrequent along the railroad.

PETALOSTEMON VIOLACEUS, (Willd.) Michx. Fl. — *Dalea violacea*, Willd. Spec. iii. p. 1337.—*D. purpurea*. Vent. Hort. Cels. 1800.
Prairies: abundant.

P. CANDIDUS, (Willd.) Michx. Fl.—*Dalea candida*, Wild. Spec. iii.
Prairie; abundant.

P. villosus, Nutt. Gen.
A few plants collected along the railroad two miles east of Ames in 1886.

Robinia pseudacacia, L. Spec.
Sparingly introduced along hedges two miles south of the College; four miles south of Northwest School.

ASTRAGALUS CARYOCARPUS, Ker, Bot. Reg. 1816.
Prairie; not uncommon.

A. CANADENSIS, L. Spec.
Moist clay banks; frequent.

GLYCYRRHIZA LEPIDOTA, Pursh, Fl.
Prairie; scarce.

North of College beyond Squaw creek; near Ontario depot.

DESMODIUM GRANDIFLORUM, (Walt.) DC. Prod. ii. — *Hedysarum grandiflorum*, Walt. Fl.—*D. acuminatum*, DC. Prod. ii.
Upland woods; common.

D. ILLINOENSE, Gray, Proc. Amer. Acad. viii. 1870.
Prairie; not uncommon.

D. DILLENII, Darl. Fl. Cest. 2d ed.
Borders of upland woods; abundant.

Stem pubescent at summit, glabrate below; racemes usually simple and rather few-flowered; pods often with as many as six joints.

D. CANADENSE, (L.) DC. Prod. ii.—*Hedysarum Canadense*, L. Spec.
Upland woods; frequent.

D. SESSILIFOLIUM, (Torr.) Torr. & Gray, Fl. i. p. 363.—"*Hedysarum sessilifolium*, var. *angustifolium*, Tor." in Curtis. Pl. Wilmington. 1834.
Copses; abundant.

LESPEDEZA FRUTESCENS, (Willd.) Ell. Sk. ii.—*Hedysarum frutescens*, Willd. Spec. iii.—*L. capitata*, Michx. Fl.
Prairie; abundant.

L. LEPTOSTACHYA, Engelm. in Gray, Proc. Amer. Acad. xii. 1876.
Prairie; rare.

Beyond road south of Veterinary Barn. There is also a specimen in the Engelmann herbarium from Ames, collected by Dr. Arthur.

Vicia Cracca, L. Spec.
A few plants collected on the campus near South Hall.

V. AMERICANA, Muhl. in Willd. Spec. iii.
Low ground; frequent.

LATHYRUS VENOSUS, Muhl. in Willd. Spec. iii.
Upland woods; infrequent.

Skunk river northeast of Ames, and elsewhere.

L. PALUSTRIS, L. Spec.
Sloughs; not uncommon.

APIOS TUBEROSA, Moench, Meth. 1794.
Moist thickets; not uncommon.

STROPHOSTYLES ANGULOSA, (Ort.) Ell. Sk. ii.—*Phaseolus angulosus*, Ort. Nov. Pl. 1797-1800.

AMPHICARPÆA COMOSA, (L.) Riddell, Synops. 1835.—*Glycine comosa*, L. Spec.—*A. monoica*, Ell. Journ. Acad. Phil. i. 1818.?
Low copses; frequent.

CASSIA CHAMÆCRISTA, L. Spec.
Dry, sterile soil; frequent.

GYMNOCLADUS DIOICUS, (L.) Koch, Dendr. 1869–1873.—*Guilandina dioica*. L. Spec.—*Gymnocladus Canadensis*. Lam. Dict. i.
Low woods; infrequent.

GLEDITSCHIA TRIACANTHOS, L. Spec.
Lowland woods; frequent.

ROSACEÆ.

PRUNUS AMERICANA, Marsh. Arbust.
Thickets; frequent.

P. PENNSYLVANICA, L. f. Suppl. 1781.
According to Prof. Budd. this is not uncommon in upland woods.

P. VIRGINIANA, L. Spec.
Upland woods; frequent.

P. SEROTINA, Ehr. Beitr. iii. 1789.
Woods; frequent.

RUBUS OCCIDENTALIS, L. Spec.
Upland woods; frequent.

R. VILLOSA, Ait. Hort. Kew.
Upland woods; frequent.

GEUM ALBUM, Gmel. Syst. ii. 1791.
Woods; frequent.

Watson's Index gives as synonyms of this: *G. Canadense*, Jacq. Hort. Vind. ii. 1772, [*G. Canadense*, Murr. in Comm. Soc. reg. sci. Goett. v. 1783? is *G. strictum*, Ait. Hort. Kew.] and *G. Carolinianum*, Walt. Fl. In the absence of sufficient literature, I have retained *G. album*, as given in the N. Y. Catalogue and Britton, Fl. N. Jersey.

G. VIRGINIANUM, L. Spec.
Low ground; frequent.

FRAGARIA VIRGINIANA, Duch., var. ILLINOENSIS, (Prince). Gray, Man. 5th ed.—*F. Illinoensis*, Prince (said to be in a seedsman's catalogue).
Moist prairie and banks; abundant.

POTENTILLA ARGUTA, Pursh, Fl.
Prairie; abundant.

P. NORVEGICA, L. Spec.
Low ground; abundant.

Erect, simple, or branching above; leaves all 3-foliolate; petals about the length of the calyx.

P. RIVALIS, Nutt., var. PENTANDRA, (Engel.) Watson, Proc. Amer. Acad. 1873 (Revision Poten.)—*P. pentandra*. Engel. in Torr. & Gray, Fl. i. p 447.

Sandy soil; infrequent.

Along the railroad near lower gate; near first bridge on wagon road south of Ames; bottom-land in "the forks."

Resembles *P. Norvegica*, and often grows with it, but always in sandy soil. Usually much branched at the very base, but sometimes simple; branches ascending; lower leaves 3-foliolate, but lateral leaflets parted almost to the base, thus appearing as if palmately 5-foliolate; petals minute; stamens usually 6, sometimes more; flowers smaller and pedicels more slender than in the last. The same was collected at Davenport, Sioux City, and Hamburg. The descriptions of this read, "stamens 5, opposite the sepals," but all the flowers examined showed usually 6, or sometimes 7 or 8. In the Engelmann herbarium is a specimen from Neosho river bottom, labelled "*P. pentandra*, Engel.," accompanied by a sketch showing 5 stamens. Another specimen from Humboldt county, Iowa, collected by Dr. J. C. Arthur, is accompanied by a note, "stamens 6-8 (10?)," etc.

P. Anserina, L. Spec.

Abundant along the railroad embankment at Jewell Junction.

P. CANADENSIS, L. Spec.

Dry banks; abundant.

AGRIMONIA EUPATORIA, L. Spec.

Woods; abundant.

ROSA BLANDA, Ait., var. ARKANSANA, (Porter) Best, Torr. Bull. xvii. 1890.—*R. Arkansana*, Porter, Syn. Fl. Col. 1874.

Prairie; abundant.

This is the common wild rose of central Iowa. It has passed for *R. blanda*, Ait.

PIRUS CORONARIA, L. Spec.

Copses; frequent.

CRATÆGUS COCCINEA, L., var. MOLLIS, Torr. & Gray, Fl. i. p. 465.

Woods: frequent.

C. TOMENTOSA, L. Spec.

Woods, chiefly lowland: frequent.

C. PUNCTATA, Jacq. Hort. Vind. i. 1770.

Thickets; frequent.

AMELANCHIER CANADENSIS, (L.) Torr. & Gray, Fl. i. p. 473.

Mespilus Canadensis, L. Spec.

Clay bluffs; not uncommon. Hoggatt's woods; more abundant on Skunk river.

SAXIFRAGACEÆ.

HEUCHERA HISPIDA, Pursh, Fl.

Prairie; frequent.

PARNASSIA CAROLINIANA, Michx. Fl.

Swamps; scarce.

Bog near pump-house, and elsewhere.

RIBES CYNOSBATI, L. Spec.

Woods; not uncommon.

R. GRACILE, Michx. Fl.

Woods; abundant.

R. FLORIDUM, L'Her. Stirp. i. 1784.
Woods: not uncommon.

CRASSULACEÆ.

PENTHORUM SEDOIDES, L. Spec.
Wet places; common.

HALORAGEÆ.

MYRIOPHYLLUM SPICATUM, L. Spec.
Ponds; scarce.

Big Prairie; abundant at Cairo lake and all the larger ponds in the county.

PROSERPINACA PALUSTRIS, L. Spec.
Ponds; scarce.

LYTHRACEÆ.

AMMANNIA COCCINEA, Rottb. Pl. Hort. rar. 1773 (fide Koehne).
Sloughs and river banks; scarce.

LYTHRUM ALATUM, Pursh, Fl.
Low ground; abundant.

ONAGRACEÆ.

LUDWIGIA POLYCARPA, Short & Peter, Pl. Ky. 2d suppl. 1835.
Wet places; frequent.

EPILOBIUM LINEARE, Muhl. Cat.
Wet places; scarce.

E. COLORATUM, Muhl. in Willd. Enum.
Low ground; abundant.

E. ADENOCAULON, Haussku. in Oesterr. bot. Zeitschr. xxix. 1879.
Wet places; frequent.

ŒNOTHERA BIENNIS, L. Spec.
Neglected ground; abundant.

Œ. RHOMBIPETALA, Nutt. in Torr. & Gray, Fl. i. p. 493.
Sandy soil; abundant along sand-hills south of Northwest School.

Œ. SERRULATA, Nutt. Gen.
Dry clay soil; infrequent.

CIRCÆA LUTETIANA, L. Spec.
Woods; abundant.

CUCURBITACEÆ.

ECHINOCYSTIS ECHINATA (Muhl.) B. S. P. Cat.—*Momordica echinata*, Muhl. Ind. Fl. Lanc. 1793.
Banks of streams; frequent.

FICOIDEÆ.

MOLLUGO VERTICILLATA, L. Spec.
Sandy places; common.

UMBELLIFERÆ.

Daucus Carota, L. Spec.

Occasionally spontaneous around gardens.

CONIOSELINUM CHINENSE, (L.) B. S. P. Cat.—*Athamanta Chinensis*. L. Spec.—*C. Canadense*, Torr. & Gray, Fl. i. p. 619.

Woody hillside a mile and a half east of Ames.

TIEDEMANNIA RIGIDA, (L.) C. & R. Bot. Gaz. xii. 1887.—*Sium rigidum*. L. Spec.

Sloughs; abundant.

HERACLEUM LANATUM, Michx. Fl.

Rich moist woods; not uncommon.

Pastinaca sativa, L. Spec.

Frequently spontaneous in proximity to gardens.

POLYTÆNIA NUTTALLII, DC. Mem. Umbel. 1829.

Dry places; scarce.

Field two miles and a half east of Ames.

Fœniculum officinale, Alli. Pedem. 1785 (1795, ex Nyman's Conspectus).—*Anethum Fœniculum*. L. Spec.

Occasionally escapes from gardens.

PIMPINELLA INTEGERRIMA, (L.) Benth. & Hook. Gen. Pl. 1. 1867. —*Smyrnium integerrimum*, L. Spec.

Rocky woods; abundant.

CRYPTOTÆNIA CANADENSIS, (L.) DC. Mem. Umbel. 1829.—*Sison Canadense*, L. Spec.

Low woods; common.

SIUM CICUTÆFOLIUM, Gmel. Syst. ii. 1791.

Sloughs; frequent.

ZIZIA AUREA, Koch, Umbel. (Nov. Act. Leop. xii. 1824).

Low prairie; abundant.

CICUTA MACULATA, L. Spec.—*C. virosa*, L., var. *maculata*, C. & R. Revis. Umbel. 1888.

Sloughs; abundant.

For remarks on this species see Greene, Pitt. i. p. 271, and ii. p. 1.

CHÆROPHYLLUM PROCUMBENS, (L.) Crantz, Umbel. 1767.—*Scandix procumbens*, L. Spec.

Low woods; infrequent.

OSMORRHIZA CLAYTONI, (Michx.) B. S. P. Cat.—*Myrrhis Claytoni*. Michx. Fl.—*O brevistylis*, DC. Prod. iv.

Rich woods; abundant.

O. LONGISTYLIS, (Torr.) DC. Prod. iv.—*Myrrhis longistylis*, Torr. Fl. U. S.

Rich woods; abundant.

ERYNGIUM YUCCÆFOLIUM, Michx. Fl.

Wet prairie; abundant.

For a note on nomenclature see Greene, Pitt. i. p. 185.

SANICULA CANADENSIS, L. Spec.—*S. Marylandica*, L., var. *Canadensis*, Torr. Fl. U. S.
Lowland woods; frequent.

Var. MARYLANDICA, (L.)—*S. Marylandica*. L. Spec.
Lowland woods; common.

ARALIACEÆ.

ARALIA RACEMOSA, L. Spec.
Rich woods; not uncommon.

A. NUDICAULIS, L. Spec.
Woods along clay bluffs; infrequent.

A. quinquefolia, (L.) Decaisne & Planch. Rev. Hort. 1854.—*Panax quinquefolia*, L. Spec.
One specimen among my plants collected at Ames, but locality not noted.

CORNACEÆ.

CORNUS CIRCINATA. L'Her. Cornus. 1788.
Rich woods; rare.
Clear creek one mile west of College, and elsewhere.

C. SERICEA, L. Mant. p. 199.
Moist woods; abundant.

C. ASPERIFOLIA, Michx. Fl.
Lowland woods; abundant.

C. CANDIDISSIMA, Marsh. Arbust.— *C. paniculata*, L'Her. Cornus, 1788.
Woods; abundant.

C. ALTERNIFOLIA, L. f. suppl. 1781.
Rocky woods; rare.

CAPRIFOLIACEÆ.

SAMBUCUS CANADENSIS, L. Spec.
Lowland woods; abundant.

VIBURNUM PUBESCENS, Pursh, Fl.
Rocky woods; not uncommon.
Fruit ovoid, dark purple, 3 to 4 lines long; ripe in July.

V. LENTAGO, L. Spec.
Rocky woods; not uncommon.
A small tree. Fruit black, 4 to 6 lines long, with very flat stone; ripe in September.

TRIOSTEUM PERFOLIATUM, L. Spec.
Upland woods; abundant.

Symphoricarpus vulgaris, Michx. Fl.
"Ames." One specimen in I. A. C. herbarium.

S. occidentalis, Hook. Fl. i.
Woods; rare.
"Ames," Bessey; Anderson. Both specimens in I. A. C. herbarium. Occurs frequently at Jewell Junction, Des Moines river at Boone, and around Des Moines.

LONICERA GLAUCA, Hill, Hort. Kew, 1768.
Rocky woods; infrequent.
Hoggatt's woods; Skunk river northeast of Ames.

RUBIACEÆ.

CEPHALANTHUS OCCIDENTALIS, L. Spec.
Sloughs; infrequent.
A low shrub, 3 to 4 feet high. (In eastern Iowa it grows taller—6 to 8 ft. high.)

GALIUM APARINE, L. Spec.
Low woods; abundant.
Annual; stems reclining, often forming dense mats; leaves 6, or mostly 8, linear to oblanceolate; fruit hispidulous.

G. TRIFIDUM, L. Spec.
Wet places; common.
A low diffusely-branched perennial; leaves linear, about ½ inch long, 4 to 6 in a whorl; fruit smooth. A form with mostly 6 narrowly elliptical leaves, grows abundantly in upland woods.

Var. LATIFOLIUM, Torr. Fl. U. S.
Wet places, common.
Plant usually less branched; leaves broader.

G. CONCINNUM, Torr. & Gray, Fl. ii. p. 23.
Dry hills; abundant.
Resembles *G. trifidum*, but leaves all in sixes and flowers more numerous.

G. TRIFLORUM, Michx. Fl.
Woods; frequent.
Leaves elliptical-lanceolate, all in sixes, larger and broader than in the other species; fruit hispidulous.

COMPOSITÆ.

VERNONIA FASCICULATA, Michx. Fl.
Bottom lands; common.

EUPATORIUM PURPUREUM, L. Spec.
Low woods; not uncommon.

Var. MACULATUM, (L.) Darl. Fl. Cest. 1837.—*E. maculatum*, L. Amoen. iv. 1760.—*E. purpureum*. β. L. Spec.
Sloughs and low woods; frequent.
This is more common than the type, and easily distinguished; the inflorescence is denser, the leaves shorter, and veins more reticulated.

E. ALTISSIMUM, L. Spec.
Dry banks; infrequent.

E. PERFOLIATUM, L. Spec.
Low grounds; common.

E. AGERATOIDES, L. f. suppl. 1781.
Woods; common.

KUHNIA EUPATORIOIDES, L. Spec. 2d ed. appx.
Dry prairie; abundant.

Var. GLUTINOSA, (Ell.)—*K. glutinosa*, Ell. Sk. ii.—*K. eupatorioides*, L., var. *corymbulosa*. Torr. & Gray, Fl. ii.
Dry prairies; abundant.

LIATRIS CYLINDRACEA, Michx. Fl.
Prairie: frequent.

L. SCARIOSA, (L.) Willd. Spec. iii. p. 1635. — *Serratula scariosa*, L Spec.
Prairie; abundant.

L. PYCNOSTACHYA, Michx. Fl.
Low prairie: abundant.

SOLIDAGO.

* Inflorescence in the axils of feather-veined leaves.

S. LATIFOLIA, L. Spec.

Rich woods; frequent.

Stem smooth, angled, more or less zigzag; leaves ovate, large and thin, or upper smaller and lanceolate, all tapering into margined petioles, sharply and deeply serrate, pubescent beneath.

* * Inflorescence a terminal panicle.

+ Leaves not triple-ribbed.

++ Racemes not secund.

S. SPECIOSA, Nutt., var. ANGUSTATA, Torr. & Gray, Fl. ii. p. 205.
Prairie; infrequent.

Stems strict, 2 to 3 feet high; leaves entire or nearly so, lower spatulate, upper narrowly elliptical, becoming small and bract-like in the inflorescence.

True *S. speciosa*, Nutt. is abundant in eastern Iowa, but I have not seen it here. It should be sought along the borders of upland woods.

++ ++ Racemes secund. (*S. nemoralis* might be sought here.)

S. ULMIFOLIA, Muhl. in Willd. Spec. iii.
Woods; common.

Leaves thin, elliptical, pointed at both ends, sharply serrate, or sometimes the upper entire; branches of panicle long, slender and recurving. Quite variable. (For note on *S. lateriflora*, Ait., see Gray, Proc. Amer. Acad. xvii. p. 180.)

+ + Leaves more or less triple-ribbed.

++ Stem smooth, at least up to panicle.

S. MISSOURIENSIS, Nutt. Jour. Acad. Phil. vii. 1834.
Prairie; common.

Low, seldom more than 2 feet high; glabrous throughout; leaves narrow, thick and rather rigid, entire or sparingly denticulate. Flowering earlier than the other species.

S. SEROTINA, Ait. Hort. Kew.
Open ground or along fences and roadsides; common.

Tall, glabrous up to the ample panicle; leaves large and sharply serrate.

Var. GIGANTEA, (Ait.) Gray, Proc. Amer. Acad. xvii. 1882.—*S. gigantea*, Ait. Hort. Kew.
Open ground; not uncommon.

Around North Hall and elsewhere. Leaves more or less pubescent beneath.

++ ++ Stem pubescent.

S. CANADENSIS, L. Spec.

Open ground, roadsides, moist woods, etc.; common.

Resembles *S. serotina* in general appearance, but stem, and usually smaller and narrower leaves, pubescent.

Var. PROCERA, (Ait.) Torr. & Gray, Fl. ii. p. 224.—*S. procera*, Ait. Hort. Kew.

Open ground; not uncommon.

Plant paler, leaves less serrate, and panicle much smaller than in *S. Canadensis*.

S. NEMORALIS, Ait. Hort. Kew.

Dry gravelly soil: abundant.

Stem (a few inches to 2 feet high) cinereous-pubescent; leaves spatulate or oblanceolate, entire, or the lower sparingly serrate; panicle recurved, or in the taller specimens sometimes erect.

* * * Heads disposed in corymbiform or cymose clusters.

+ Stem densely pubescent.

S. RIGIDA, L. Spec.

Prairie: common.

Stem 2 to 3 feet high, softly pubescent or scabrous; radical leaves on long petioles; lower cauline, oblanceolate tapering into slender petioles; upper, ovate to oblong, sessile; all entire or nearly so.

+ + Stem nearly or quite glabrous.

S. RIDDELLII, Frank, in Riddell, Synops. 1835.

Sloughs, often growing in the water; infrequent.

Low prairie north of Ames, and elsewhere. Stem smooth, 1 to 2 ft. high; leaves entire, long and narrow, erect from a sheathing base.

S. GRAMINIFOLIA, (L.) Ell. Sk. ii.— *Chrysocoma graminifolia*, L. Spec.—*S. lanceolata*, L. Mant. p. 114.

Wet places; abundant.

Stem much branched, usually smooth, 1 to 3 feet high, with long and slender rootstocks; leaves narrowly lanceolate, 3-nerved, heads glomerate-sessile. Flowering late.

BOLTONIA ASTEROIDES, (L.) L'Her. Sert. Angl. 1788.—*Matricaria asteroides*. L. Mant. p. 116.

Sloughs; frequent.

This has the general appearance of an Aster, but the pappus consists of two (under a lens, setose) awns and a ring of short bristles; the achene is setulose on the upper part of its winged margin.

ASTER OBLONGIFOLIUS, Nutt., var. RIGIDULUS, Gray, Syn. Fl. i. 2.

Rocky bluffs; infrequent.

A. NOVÆ-ANGLIÆ, L. Spec.

Sloughs and moist places; abundant.

Var. ROSEUS, (Desf.) DC. Prod. v.—*A. roseus*, Desf. Cat. H. Par. 3d ed.

With the above: an infrequent form.

A. SERICEUS, Vent. Hort. Cels. 1800.

Dry banks: infrequent.

A. AZUREUS, Lindl. in Hook. Comp. Bot. Mag. i. 1835.
Prairies and thickets; frequent.

A. CORDIFOLIUS, L. Spec.
Woods; common.

A. LÆVIS, L. Spec.
Rocky woods, especially bluffs; not uncommon.

A. AMETHYSTINUS, Nutt. Trans. Amer. Phil. Soc. vii. 1841.
Moist places; scarce.

A. MULTIFLORUS, Ait. Hort. Kew.
Prairie; common.

A. LATERIFLORUS, (L.) Britton, Trans. N. Y. Acad. Sci. ix. 1889. —*Solidago lateriflora*. L. Spec.—*A. diffusus*. Ait. Hort. Kew.
Low woods; abundant.

A. PANICULATUS, Lam. Dict. i.
Low ground; common.

A. PRENANTHOIDES, Muhl. in Willd. Spec. iii.
Low ground; infrequent.

A. PUNICEUS, L., var. LUCIDULUS, (Wendr.) Gray, Syn. Fl. i. 2.—*A. lucidulus*. Wendr. Ind. Sem. Marb.
Moist places; not uncommon.

A. UMBELLATUS, Mill. Dict.
Low ground; not uncommon.

Var. PUBENS, Gray, Syn. Fl. i. 2.
Low ground; infrequent.

ERIGERON CANADENSIS, L. Spec.
Neglected ground; common.

Commonly 4 or 5 feet high, but depauperate specimens sometimes only a few inches.

E. DIVARICATUS, Michx. Fl.
Prairie or open woods; not uncommon.

E. ANNUUS, (L.) Pers. Syn. ii.—*Aster annuus*, L. Spec.
Prairie and neglected fields; abundant.

The typical form is pubescent with spreading hairs; leaves broad, thinnish and toothed. Passes into the next.

E. RAMOSUS, (Walt.) B. S. P. Cat.—*Doronicum ramosum*, Walt. Fl.—*E. strigosus*. Muhl. in Willd. Spec. iii.
Dry ground; common.

Typical form pubescent with appressed hairs; leaves narrowly spatulate, thickish, usually entire. Apparently crosses freely with *E. annuus*.

E. PHILADELPHICUS, L. Spec.
Upland woods; abundant.

ANTENNARIA PLANTAGINIFOLIA, (L.) Hook. Fl. i.—*Gnaphalium plantaginifolium*. L. Spec.
Upland woods; common.

SILPHIUM LACINIATUM, L. Spec.

Prairie: frequent.

Radical leaves varying from narrowly oblanceolate and entire to broad and twice pinnately parted.

S. INTEGRIFOLIUM, Michx. Fl.

Open upland woods; frequent in the woods west of Nevada.

Leaves sometimes narrowed to a sessile base.

S. PERFOLIATUM, L. Spec. 2d ed.

Moist soil; frequent.

AMBROSIA TRIFIDA, L. Spec.

Low ground; common.

Var. INTEGRIFOLIA, (Muhl.) Torr. & Gray, Fl. ii. p. 290.—*A. integrifolia*, Muhl. in Willd. Spec. iv.

A form with entire leaves.

A. ARTEMISIÆFOLIA, L. Spec.

Prairies and roadsides: common and quite variable.

A. PSILOSTACHYA, DC. Prod. v.

Prairie: infrequent.

Dry hills north of College, beyond Squaw creek.

XANTHIUM CANADENSE, Mill. Dict. 8th ed.

Cultivated ground and waste places; common.

X. Canadense, Mill., var. *echinatum*. (Murr.) Gray, Syn. Fl. i. 2.—*X. echinatum*, Murr. in Comm. Soc. reg. sci. Goett. vi. 1783-4. If I have the right understanding of this variety, it does not occur in our flora.

HELIOPSIS SCABRA, Dunal, Mem. Mus. Paris, v. 1819.

Prairie and open woods: common.

It has the appearance of *Helianthus*, but the ray-flowers are fertile.

ECHINACEA ANGUSTIFOLIA, DC. Prod. v.

Prairie; abundant.

RUDBECKIA LACINIATA, L. Spec.

Low woods; common.

R. TRILOBA, L. Spec.

Moist woods; common.

R. SUBTOMENTOSA, Pursh, Fl.

Moist prairie or open woods; frequent.

R. HIRTA, L. Spec.

Prairie; common.

LEPACHYS PINNATA, (Vent.) Torr. & Gray, Fl. ii. p. 314.—*Rudbeckia pinnata*, Vent. Hort. Cels. 1800.

Prairie; abundant.

HELIANTHUS ANNUUS, L. Spec.

Waste grounds; infrequent.

Ordinarily tall and stout, but ours is frequently depauperate, sometimes only a few inches high with a single small head.

H. DIFFUSUS, Sims, Bot. Mag. 1818.—*H. rigidus*, Desf. Cat. Hort. Paris. 3d ed. 1829.

Prairies; frequent.

H. LÆTIFLORUS, Pers. Syn. ii.

Prairie; infrequent.

Along the railroad near the stone arch.

H. GROSSE-SERRATUS, Martens, Sel. Sem. Hort. Lovan. 1839.

Low ground; abundant.

H. STRUMOSUS, L. Spec.

Borders of woods; abundant.

Var. MOLLIS, (Willd.) Torr. & Gray, Fl. ii. p. 327.—*H. mollis*, Willd. Spec. iii.

Woods; infrequent.

Leaves often somewhat cordate at base, softly pubescent beneath.

H. TRACHELIIFOLIUS, Willd. Spec. iii.

Borders of woods; scarce.

H. TUBEROSUS, L. Spec.

Open places; abundant.

ACTINOMERIS ALTERNIFOLIA, (L.) DC. Prod. v.—*Coreopsis alternifolia*, L. Spec.—*A. squarrosa*, Nutt. Gen.

Woods in low ground; frequent.

COREOPSIS PALMATA, Nutt. Gen.

Prairie; abundant.

Specimens sometimes occur with narrow, entire leaves.

C. TRIPTERIS, L Spec.

Upland woods; infrequent.

Woods west of Nevada; Squaw creek 3 miles northwest of College.

BIDENS FRONDOSA, L. Spec.

Moist ground; common.

B. CONNATA, Muhl. in Willd. Spec. iii.

Wet places; common.

B. CERNUA, L. Spec.

Wet places; common.

B. CHRYSANTHEMOIDES, Michx. Fl.

Wet places; common.

B. Beckii, Torr. in Spreng. Neu. Entd. ii. 1821.

I observed a few plants in a pond north of Ames in 1883, but have no specimens.

HELENIUM AUTUMNALE, L. Spec.

Low ground; common.

DYSODIA PAPPOSA, (Vent.)—*Tagetes papposa*, Vent. Hort. Cels. 1800.—*D. chrysanthemoides*, Lag. Nov. Gen. & Spec. 1816.

Sterile soil; frequent.

The pappus consists of "scales dissected into bristles" instead of "capillary bristles," as it may at first appear.

ANTHEMIS COTULA, L. Spec.

Roadsides; common.

A. arvensis, L. Spec.

"Ames-Bessey." Specimen in I. A. C. herbarium.

ACHILLEA MILLEFOLIUM, L. Spec.

Prairie: common.

Chrysanthemum Leucanthemum, L. Spec.

Plants occur occasionally on the Campus, along the railroad, and elsewhere, but the species has not, so far as I know, become established.

Tanacetum vulgare, L. Spec.

Escaped along roadsides in a few localities.

ARTEMISIA CAUDATA, Michx. Fl.

Sandy soil; abundant along the sand-hills south of the Northwest School.

A. DRACUNCULOIDES, Pursh, Fl.

Prairie: not uncommon.

A. SERRATA, Nutt. Gen.

Low ground: infrequent.

Bottom-land in "the forks": quite abundant on Clear creek about one mile west of the College.

A. LUDOVICIANA, Nutt. in Torr. & Gray, Fl. ii. p. 420.

Prairie: common.

Leaves incised, or entire (var. *gnaphalodes*).

A. BIENNIS, Willd. Phytog. 1794.

Dry and sterile ground: frequent.

SENECIO AUREUS, L. Spec.

Marshy places; not uncommon.

Var. OBOVATUS, (Muhl.) Torr. & Gray, Fl. ii. p. 442.—*S. obovatus*, Muhl. in Willd. Spec. iii.

Wet prairie: infrequent.

Var. BALSAMITÆ, (Muhl.) Torr. & Gray, l. c.—*S. balsamitæ*, Muhl. l. c.

Rocky bluffs on Des Moines river at Boone.

CACALIA TUBEROSA, Nutt. Gen.

Wet prairie; frequent.

ERECHTITES HIERACIFOLIA, (L.) Raf. in DC. Prod. vi.—*Senecio hieracifolia*. L. Spec.

Moist places; not common.

ARCTIUM LAPPA, L. Spec.

Neglected ground; common.

CNICUS LANCEOLATUS, (L.) Hoffm. Fl. Germ. iv. 1804.—*Carduus lanceolatus*, L. Spec.

Pastures: infrequent.

Rather abundant in a pasture about one mile northeast of Ames; also west of the College beyond the brick-kiln.

C. ALTISSIMUS, (L.) Willd. Spec. iii.—*Carduus altissimus*, L. Spec.
Open woods and roadsides; abundant.

Var. DISCOLOR, (Muhl.) Gray, Proc. Amer. Acad. xix. 1883.—*C. discolor*, Muhl. in Willd. Spec. iii.
Borders of fields, along fences, etc.; common.

Seems to pass into *C. altissimus*. The white-flowered form occurs along Skunk river.

C. odoratus, Muhl. Cat. 1st ed.—*Carduus odoratus*, Muhl. Cat. 2d ed. — *C. pumilus*, Torr. Compend. 1826.
Pastures; not uncommon.

[Of this, Mr. Watson writes:—The *Cnicus* sent is not true *C. pumilus*. While the foliage and shape of the involucral scales agree well enough, the latter have a black-glutinous thickening above, which I do not find on eastern specimens. Of more importance are the more acuminate anthers, like those of the other western species of the group. It will not go into *C. Drummondii*, and I suspect that it is a fairly good undescribed species.—T.]

C. arvensis, (L.) Hoffm. Fl. Germ. iv. 1804.—*Serratula arvensis*, L. Spec.
Introduced in a few places but not established.

HIERACIUM SCABRUM, Michx. Fl.
Upland woods; a few specimens collected on Onion creek, northwest of stone arch, in 1886.

H. LONGIPILUM, Torr. in Hook. Fl. i. (note under *H. Scouleri*).
Prairie; infrequent.

Campus south of Prof. Osborn's house; abundant a few rods south of the veterinary barn.

PRENANTHES RACEMOSA, Michx. Fl.
Low prairie; not uncommon.

P. ASPERA, Michx. Fl.
Prairie; infrequent.

P. ALBA, L. Spec.
Upland woods; frequent.

TROXIMON CUSPIDATUM, Pursh, Fl.
Prairie; scarce.

Along railroad 3 miles east of Ames, and elsewhere.

TARAXACUM OFFICINALE, (With.) Weber in Prim. Fl. Holsat. 1780.
—*Leontodon officinale*, With. Bot. Arrang. 1776.
Grass land; common.

LACTUCA SCARIOLA, L. Spec. 2d ed.
Waste places; becoming frequent.

This was first described under *L. Serriola* (Amœn. Acad. iv. p. 328), which is probably a typographical error, for in the Species, 2d edition, the description is the same as in the Amœnitates, to which reference is made without comment.

L. CANADENSIS, L. Spec.
Moist places; common.

L. LUDOVICIANA, (Nutt.) DC. Prod. vii.—*Sonchus Ludovicianus*, Nutt. Gen.

L. FLORIDANA, (L.) Gaertn. Fruct. ii. 1791.—*Sonchus Floridanus*, L. Spec.

Shady places; frequent.

L. SPICATA, (Lam.)—*Sonchus spicatus*, Lam. Dict. iii.—*L. leucophæa*, Gray, Proc. Amer. Acad. xix. 1883.

Moist open woods; not uncommon.

Lactuca leucophæa, Sibth. Fl. Græc. 4. 794, 1833 (ex DC. Prod. vii.) is placed by Boissier (Fl. Orient.) under *L. Cretica*, but it may be revived at any time, in which case *L. leucophæa*, Gray, would be untenable.

SONCHUS OLERACEUS, L. Spec.

I have no specimen of this, but Prof. Pammel assures me that it occurs at Ames.

S. ASPER, Vill. Fl. Delph. 1785.

Waste places: not uncommon.

LOBELIACEÆ.

LOBELIA CARDINALIS, L. Spec.

Wet places in lowland woods; frequent.

L. SYPHILITICA, L. Spec.

Low ground; abundant.

L. SPICATA, Lam., var. HIRTELLA, Gray, Syn. Fl. ii. 1.

Prairie; frequent.

L. INFLATA, L. Spec.

Open woods; a few specimens found in the woods west of cemetery.

CAMPANULACEÆ.

SPECULARIA PERFOLIATA, (L.) A. DC. Mon. Camp. 1830.—*Campanula perfoliata*, L. Spec.

CAMPANULA APARINOIDES, Pursh, Fl.

Low grassy places; not uncommon.

C. AMERICANA, L. Spec.

Moist woods; abundant.

ERICACEÆ (MONOTROPEÆ).

MONOTROPA UNIFLORA, L. Spec.

I have one specimen collected near the stone arch, a few years ago, by Mr. C. L. Spencer.

PRIMULACEÆ.

STEIRONEMA CILIATUM, (L.) Raf. Ann. Gen. Phys. Brux. vii. 1820. —*Lysimachia ciliata*, L. Spec.

Low ground; abundant.

S. LANCEOLATUM, (Walt.) Gray, var. HYBRIDUM, (Michx.) Gray, Syn. Fl. ii. 1.—*Lysimachia hybrida*, Michx. Fl.

Sloughs; abundant.

S. QUADRIFLORUM, (Sims).—*Lysimachia quadriflora*, Sims, Bot. Mag. 1803.—*S. longifolium*, Gray, Proc. Amer. Acad. xii. 1876.

Low prairie: frequent.

LYSIMACHIA THYRSIFLORA, L. Spec.

Ponds; becoming rare.

OLEACEÆ.

FRAXINUS AMERICANA, L. Spec. 2d ed.

Upland woods.

This species is apparently rare. Although diligently searched for, only one tree was found near the railroad, north of the brick-kiln. It is easily recognized by its cylindrical fruit with the wing not decurrent, and by its rather slender-petioled leaflets being whitened beneath.

F. VIRIDIS, Michx. f. Hist. Arb. Am. iii. 1813.

Woods; abundant.

A small or medium sized tree, growing in both upland and lowland woods; leaflets mostly 5, oval to narrowly lanceolate, sharply serrate, or nearly entire, glabrous or with more or less pubescence along the veins beneath, tapering into a somewhat margined petiole; fruit with slender striate body, tapering to an acute base, and decurrent obovate oblong or lanceolate retuse or acute wing 1 to 3 times the length of the body.

Var. PUBESCENS.

Upland woods; Ames; Hamilton county, Fremont county, Sioux City.

This differs from *F. viridis* in having the twigs of the season densely pubescent.

F. SAMBUCIFOLIA, Lam. Dict. ii.

Along streams; infrequent.

A medium sized tree with oblong spray, dark green foliage, and close bark, becoming mottled with white as in the Black Maple; leaflets sessile, 7 to 11. Occurs along the clay bluffs of Skunk river, mostly near the water but often on the sides or top; also sparingly on Clear creek about one mile west of the College, on Onion creek, and in a few other localities.

APOCYNACEÆ.

APOCYNUM ANDROSÆMIFOLIUM, L. Spec.

Rich open woods; frequent.

A. CANNABINUM, L. Spec.

Moist banks; abundant.

ASCLEPIADACEÆ.

ASCLEPIAS TUBEROSA, L. Spec.

Prairie; abundant.

Var. DECUMBENS, (L.) Pursh, Fl.—*Asclepias decumbens*, L Spec.

Sterile soil; infrequent.

A. PURPURASCENS, L. Spec.

Prairie and open woods; not uncommon.

A. INCARNATA, L. Spec.

Low ground; common.

A. SYRIACA, L. Spec.—*A. Cornuti*, Decaisne in DC. Prod. viii.

Fields, pastures, and open woods; abundant.

A. SULLIVANTII, Engel. in Gray Man. 1st. ed.

Low prairie; frequent.

A. OVALIFOLIA, Decaisne in DC. Prod. viii.

Prairie; scarce.

The following specimens are in the I. A. C. herbarium: "Ames—R. Burgess, 1878;" "Ames—H. A. Gossard, 1887;" "E. Ames—E. K. Paine, 1887."

A. VERTICILLATA, L. Spec.

Banks and prairie: frequent.

Acerates Floridana, (Lam).—*Asclepias Floridana*, Lam. Dict. i. —*Acerates longifolia*, Ell. Sk. i.

Prairie; southeastern part of Story county.

A. VIRIDIFLORA, (Raf.) Ell. Sk. i.—*Asclepias viridiflora*, Raf. Med. Rep. xi. 1807. (?)

Prairie: not uncommon.

Var. LANCEOLATA, (Ives) Gray, Syn. Fl. ii. 1.—*Asclepias lanceolata*, Ives. Amer. Jour. Sci. iv. 1822. (?)

Prairie: infrequent.

GENTIANACEÆ.

GENTIANA CRINITA. Froel. Gent. 1796.

Swamps; rare.

Near pump-house, and reported elsewhere.

G. QUINQUEFOLIA, L., var. OCCIDENTALIS.—*G. quinquefolia*, Lam., var. *occidentalis*, Gray. Syn. Fl. ii. 1.

Open woods: not uncommon.

G. PUBERULA, Michx. Fl.

Prairie; infrequent.

G. ANDREWSII, Griseb. Gent. 1839.

Low ground; not uncommon.

G. FLAVIDA, Gray, Amer. Jour. Sci. 2d s. i. 1846.—*G. alba*, Muhl. Cat. 2d ed.

Low ground: infrequent.

Along the railroad east of Squaw creek bridge, and elsewhere. For note on nomenclature see Porter, Torr. Bull. xvi. 1889.

POLEMONIACEÆ.

PHLOX MACULATA, L. Spec.

Sloughs: scarce.

Near Shearer School.

P. PILOSA, L. Spec.

Low prairie; abundant.

P. DIVARICATA, L. Spec.

Woods; abundant.

POLEMONIUM REPTANS, L. Spec. 2d ed. (Syst. Nat. 10th ed. ex Richter.)

Rich woods: not uncommon.

Frequent along Skunk river north of Ames.

HYDROPHYLLACEÆ.

HYDROPHYLLUM VIRGINIANUM, L. Spec.

Low woods; common.

This is commonly quoted as H. Virginicum, L.

H. appendiculatum, Michx. Fl.

Rich woods; Des Moines river west of Boone.

ELLISIA NYCTELEA, L. Spec. 2d ed.—*Polemonium Nyctelea*, L. Spec.

Low sandy ground; abundant.

BORRAGINACEÆ.

ECHINOSPERMUM VIRGINIANUM, (L.) Lehm. Pl. Asper. 1818.—*Myosotis Virginiana*, L. Spec.—*M. Virginica*, L. Spec. 2d ed.

Woods; common.

It is probable that the name as it appears in the 2d edition of the Species, is a typographical error, which was followed by Lehmann; hence I have quoted the latter above, although in Pl. Asper. it appears as *E. Virginicum*.

E. LAPPULA, (L.) Lehm. Pl. Asper. 1818.—*Myosotis Lappula*, L. Spec.

Sterile soil; frequent.

MERTENSIA VIRGINICA, (L.) DC. Prod. x.—*Pulmonaria Virginica*, L. Spec.

Low woods; abundant.

LITHOSPERMUM LATIFOLIUM, Michx. Fl.

Upland woods; scarce.

Skunk river northeast of College, and elsewhere.

L. CANESCENS, (Michx.) Lehm. Pl. Asper. 1818.—*Batschia canescens*, Michx. Fl.

Prairie: frequent.

L. ANGUSTIFOLIUM, Michx. Fl.

Prairie: frequent.

ONOSMODIUM CAROLINIANUM, (Lam.) DC., var. MOLLIS, (Michx.) Gray. Syn. Fl. ii. 1.—*O. mollis*, Michx. Fl.

CONVOLVULACEÆ.

Ipomœa purpurea, (L.) Lam. Illustr. i.—*Convolvulus purpurea*, L. Spec. 2d ed.

Escaped from cultivation in the neighborhood of dwellings.

CONVOLVULUS SEPIUM, L. Spec.

Low ground; abundant.

C. arvensis, L. Spec.

In a field a short distance northwest of Mr. Sexton's house.

Cuscuta Cephalanthi, Engel. Amer. Jour. Sci. xliii. 2, 1842.— *C. tenuiflora*, Engel. Gray, Man. 1st ed.

Low ground: frequent.

Growing on *Salix*, *Vernonia*, *Solidago*, etc.

Dr. Engelmann first described this species under the impression that it grew only on *Cephalanthus*. The next year (l. c. xlv. 1, 1843) he says, "I did wrong therefore, to name them from the genera upon which they grew, and I should much prefer to see the names *C. Cephalanthi* changed into *C. tenuiflora*, *C. Coryli* into *C. incurva*. * * * if they had not yet been published." Nevertheless, in 1848, he makes this change.

C. CORYLI, Engel. Amer. Jour. Sci. xliii. 1842.— *C. inflexa*, Engel. Trans. St. L. Acad. Sci. i. 1859.

Dry thickets; infrequent.

Usually on *Corylus*.

C. GRONOVII, Willd. Reliqu. in Roem. & Sch. Syst. Veg. vi. 1820.

Moist places; frequent.

Growing on *Solidago* and other tall herbs.

C. GLOMERATA, Choisy, Mem. Genev. 1841.

Low ground; not uncommon.

Usually on *Solidago*. According to Dr. Engelmann (Cusc. p. 510) Rafinesque's earlier name, *C. paradoxa*, Ann. Nat. 1820, should be discarded because of the obscure description.

SOLANACEÆ.

SOLANUM NIGRUM, L. Spec.

Shady places; common.

S. CAROLINENSE, L. Spec.

Well established in the field west of the greenhouse.

Physalis Philadelphica, Lam. Dict. ii.

Waste ground: rare.

One specimen collected on the streets of Ames.

P. PUBESCENS, L. Spec.

Low ground: not uncommon.

P. VIRGINIANA, Mill. Dict.

Sandy ground: frequent.

P. LANCEOLATA, Michx. Fl.

Fields and prairies; frequent.

DATURA STRAMONIUM, L. Spec.

Pastures and waste places; infrequent.

D. TATULA, L. Spec. 2d ed.

Waste ground; not uncommon.

SCROPHULARIACEÆ.

VERBASCUM THAPSUS, L. Spec.

Neglected fields; frequent.

V. BLATTARIA, L. Spec.

Quite abundant in an open place in the woods northeast of Ames, near Skunk river.

LINARIA VULGARIS, Mill. Dict.—*Antirrhinum Linaria*, L. Spec.
Roadsides, etc.; not uncommon.

SCROPHULARIA NODOSA, L., var. MARILANDICA, (L.) Gray, Syn. Fl. ii. 1.—*S. Marilandica*, L. Spec.
Woods: common.

MIMULUS RINGENS, L. Spec.
Low woods; abundant.

ILYSANTHES GRATIOLOIDES, (L.) Benth. in DC. Prod. x.—*Capraria gratioloides*, L. Spec. 2d ed.
Wet places: not uncommon.

VERONICA VIRGINICA, L. Spec.
Upland woods: frequent.

V. ANAGALLIS, L. Spec.
Borders of ponds and streams; infrequent.

V. PEREGRINA, L. Spec.
Damp places: common.

V. ARVENSIS, L. Spec.
Upland woods; rare.

Rather abundant in locality mentioned for *Verbascum Blattaria*.

GERARDIA AURICULATA, Michx. Fl.
Low prairie: not uncommon.

G. LONGIFOLIA. Benth. Comp. Bot. Mag. i. 1835.—*G. aspera*, Benth. in DC. Prod. x.
Prairie; abundant.

G. longifolia, Nutt. Trans. Amer. Phil. Soc. N. S. v. 1837., is *G. setacea*, Walt., var. *longifolia*, Gray, (ex Syn. Fl. ii. 1).

G. TENUIFOLIA, Vahl. Symb. iii. 1794.
Low ground: abundant.

CASTILLEIA SESSILIFLORA Pursh, Fl.
Dry hills; rare.

Along railroad 3 miles east of Ames.

PEDICULARIS CANADENSIS, L. Mant. p. 86.
Upland woods; abundant.

P. LANCEOLATA, Michx. Fl.
Low prairie; not uncommon.

OROBANCHACEÆ.

Aphyllon uniflorum, (L). Gray, Man. 1st ed. (there cited "Torr. & Gray").—*Orobanche uniflorum*, L. Spec.

I have a single specimen collected northwest of the College by Mr. I. B. Clark.

LENTIBULARIACEÆ.

UTRICULARIA VULGARIS, L. Spec.
Ponds: becoming rare.

VERBENACEÆ.

VERBENA URTICÆFOLIA, L. Spec.
Low woods: common.
Originally spelled *V. urticifolia.*

V. HASTATA, L. Spec.
Low ground: common.

V. STRICTA, Vent. Hort. Cels. 1800.
Prairie: common.
Often becomes a troublesome weed in close-fed pastures.

V. BRACTEOSA, Michx. Fl.
Pastures and roadsides: abundant.

V. Aubletia, L. f. suppl. 1781.
Escaped from cultivation. Specimens contributed by Prof. Pammel.

PHRYMA LEPTOSTACHYA, L. Spec.
Woods: common.

LABIATÆ.

TEUCRIUM CANADENSE, L. Spec.
Wet places: abundant.

MENTHA CANADENSIS, L. Spec.
Wet places: abundant.
Var. BOREALIS, (Michx.) Wood. Bot. & Fl.—*M. borealis.* Michx. Fl.—*M. Canadensis*, L., var. *glabrata*, Benth. in DC. Prod. xii.
Wet places: infrequent.

LYCOPUS VIRGINICUS, L. Spec.
Wet places: frequent.

L. RUBELLUS, Moench, Meth. suppl. 1802.
Low places: infrequent.

L. SINUATUS, Ell. Sk. i.
Low ground: common.

PYCNANTHEMUM VIRGINIANUM, (L.) Pers.—*Satureia Virginiāna*, L. Spec. (ex Gray, Syn. Fl. ii. 1.)—*Pycnanthemum lanceolatum*, Pursh. Fl.—*Thymus Virginicus.* L. Mant. p. 409.
Prairie: common.
According to Bentham, *Satureia Virginiana*, L., is *Pycnanthemum muticum*, Pers. Dr. Britton informs me that in the N. Y. Catalogue the authority was inadvertently omitted, and should be *P. Virginicum*, (L.) Pers. instead of *P. Virginicum*, (L.) B. S. P. as given in Fl. N. Jersey.

HEDEOMA PULEGIOIDES, (L.) Pers. Syn. ii.—*Melissa pulegioides*, L. Spec.—*Cunila pulegioides.* L. Spec. 2d ed.
Open woods: scarce.
Abundant in locality mentioned for *Verbascum Blattaria*, and elsewhere.

H. HISPIDA, Pursh, Fl.
Dry ground: abundant.

Salvia lanceolata, Willd. Enum.
A few specimens along railroad, northwest of Ames, collected by Mr. Sirrene.

MONARDA FISTULOSA, L. Spec.
Prairie and open woods: common.

Blephilia hirsuta, (Pursh) Benth. Lab. 1832-1836.—*Monarda hirsuta*, Pursh. Fl.
Damp woods on Des Moines river at Boone.

LOPHANTHUS NEPETOIDES, (L.) Benth. Bot. Reg. xv. 1829.—*Hyssopus nepetoides*, L. Spec.
Open woods; infrequent.

L. SCROPHULARIÆFOLIUS, (Willd.) Benth. Bot. Reg. xv. 1829.—*Hyssopus scrophulariæfolius*. Willd. Spec. iii.
Open woods; not uncommon.

NEPETA CATARIA, L. Spec.
Waste places: not uncommon.

N. HEDERACEA, (L.) B. S. P. Cat.—*Glechoma hederacea*, L. Spec.—*N. Glechoma*, Benth. Lab. 1832–1836.
Around dwellings; frequent along streets of Ames.

SCUTELLARIA LATERIFLORA, L. Spec.
Moist places; abundant.

S. PARVULA, Michx. Fl.
Sandy prairie: frequent.

S. GALERICULATA, L. Spec.
Bogs; rare.
Near pump-house.

BRUNELLA VULGARIS, L. Spec.
Open woods: abundant.
In the Linnæan works it is written *Prunella*.

PHYSOSTEGIA VIRGINIANA, (L.) Benth. Lab. 1832–1836.—*Dracocephalum Virginianum*. L. Spec.
Low ground; frequent.

LEONURUS CARDIACA, L. Spec.
Waste places: a few specimens collected on Squaw creek north of College.

STACHYS PALUSTRIS, L. Spec.
Low ground; frequent.

S. ASPERA, Michx. Fl.
Low ground: abundant.

Var. TENUIFLORA, (Willd.)—*S. tenuiflora*, Willd. Spec. iii.—*S. aspera*. Michx., var. *glabra*, Gray, Syn. Fl. ii. 1.
Wet places: infrequent.

PLANTAGINACEÆ.

PLANTAGO MAJOR, L. Spec.
Waste places: not uncommon.
Prefers rather dry places, as streets, yards, and pavements. Leaves thickish, often pubescent; base of petiole green; spike usually 4 or 5 inches long, obtuse and densely flowered; capsules ovate, obtuse, with line of dehiscence in sight, i.e. above the summit of calyx.

P. RUGELII, Decaisne in DC. Prod. xiii.1.
Moist places; common.

Often growing with *P. major*, which it much resembles, though much more common; but preferring moister soil, as lowland woods, where this species alone is found. Leaves dark green, thin and smooth, in damp soil often very large and remotely denticulate; base of petiole purple; spikes a foot or more in height, with the apex attenuated and sometimes branched; capsules acutish, with line of dehiscence hidden by the calyx. This species certainly seems to be indigenous.

P. lanceolata, L. Spec.

Specimens have been occasionally collected by students, but I have none in my herbarium.

NYCTAGINACEÆ.

OXYBAPHUS NYCTAGINEUS, (Michx.) Sweet, Hort. Brit. 1827.—*Allionia nyctaginea*, Michx. Fl.
Gravelly banks; frequent.

PARONYCHIACEÆ.

ANYCHIA CANADENSIS, (L.) B. S. P. Cat.—*Queria Canadensis*, L. Spec.—*A. capillacea*, DC. Prod. iii.
Open woods; frequent.

See note on this species by Britton, Torr. Bull. xiii. 1885.

AMARANTACEÆ.

AMARANTUS RETROFLEXUS, L. Spec.
Cultivated ground; common.

A. ALBUS, L. Spec. 2d ed. (Syst. Nat. 10th ed. ex Richter).
Cultivated ground; frequent.

Most abundant in newly broken sod, when the larger specimens become "tumble weeds."

A. BLITOIDES, Wats. Proc. Amer. Acad. xii. 1876.
Dry open ground; abundant.

ACNIDA TUBERCULATA, Moq. in DC. Prod. xiii. 2.
Low ground; abundant.

CHENOPODIACEÆ.

CHENOPODIUM BOSCIANUM, Moq. Chenop. Enum. 1840.
Shady places; common.

C. ALBUM, L. Spec.
Cultivated ground; common.

C. URBICUM, L. Spec.
Waste places; infrequent.

C. HYBRIDUM, L. Spec.
Woods; infrequent.

C. Botrys, L. Spec.

A few specimens collected along the railroad near Ames in 1884.

POLYGONACEÆ.

RUMEX ALTISSIMUS, Wood, Cl.-B. 2d ed. 1847.
Low ground; common.

R. VERTICILLATUS, L. Spec.
Around ponds and ditches; abundant.

R. CRISPUS, L. Spec.
Roadsides and waste places: common.

R. maritimus, L. Spec.
Abundant on the borders of Cairo lake.

R. ACETOSELLA, L. Spec.
Pastures: infrequent.

POLYGONUM AVICULARE, L. Spec.
Yards and roadsides; common.
In dry soil it is prostrate-spreading; in damp places, erect.

P. ERECTUM, L. Spec.
Roadsides: common.

P. RAMOSISSIMUM, Michx. Fl.
Roadsides; frequent.

P. LAPATHIFOLIUM, L., var. INCARNATUM, (Ell.) Watson in Gray, Man. 6th ed.—*P. incarnatum*. Ell. Sk. i.
Damp places; common.

P. PENNSYLVANICUM, L. Spec.
Damp places: common.

P. AMPHIBIUM, L. Spec.
Ponds: infrequent.

P. MUHLENBERGII, Wats. Proc Amer. Acad. Sci. xiv. 1879.
Low and often sandy soil; abundant.
I have not been able to satisfy myself that *P. terrestre*. (Willd.) B. S. P. Cat (*P. amphibium*. L., var. *terrestre*, Willd. Spec. ii.) should be used.

P. HARTWRIGHTII, Gray, Proc. Amer. Acad. viii. 1870.
Ponds or even on sandy banks; becoming scarce.

P. orientale, L. Spec.
Neglected ground. Ames.

P. PERSICARIA, L. Spec.
Damp places: common.

P. HYDROPIPER, L. Spec.
Wet places; common.

P. ACRE, HBK. Nov. Gen. & Sp. ii. 1817.
Wet places: common.

P. VIRGINIANUM, L. Spec.
Woods; frequent.

P. CONVOLVULUS, L. Spec.
Cultivated grounds, especially stubble; common.

P. DUMETORUM, L., var. SCANDENS, (L.) Gray, Man. 5th ed.—*P. scandens*. L. Spec.
Thickets; common.

Fagopyrum esculentum, Moench, Meth. 1794.
Cultivated ground; frequent.

ARISTOLOCHIACEÆ.

ASARUM CANADENSE, L. Spec.
Low woods; frequent.

SANTALACEÆ.

COMANDRA UMBELLATA, (L.) Nutt. Gen.—*Thesium umbellatum*, L. Spec.
Prairie; frequent.

EUPHORBIACEÆ.

Euphorbia petaloidea, Engel. in Bot. Mex. Bound. ii. 2, 1859.
A single specimen found along the railroad near lower gate; others have been reported.

E. GLYPTOSPERMA, Engel. in Bot. Mex. Bound. ii. 2. 1859.
Sandy prairie and banks; common.
In an open sandy or gravelly soil it is prostrate-spreading; in grassy places it is erect or spreading.

E. MACULATA, L. Spec.
Prairies and banks; common.

E. HYPERICIFOLIA, L. Spec.
Fields, pastures, and woods; common.
Specimens sent to Dr. Millspaugh were pronounced to be this species. *E. Preslii*, Guss. Fl. Sicul. i. 1827, which much resembles it, may also occur.

E. marginata, Pursh, Fl.
Specimens are occasionally found along the railroad.

E. COROLLATA, L. Spec.
Prairie and open woods; abundant.

E. HETEROPHYLLA, L. Spec.
Rocky woods; scarce.
Bluffs, Hoggatt's woods. Leaves of specimens so far collected are all linear and entire.

E. cyparissias, L. Spec.
Escaped around gardens.

ACALYPHA VIRGINICA, L. Spec.
Low places; abundant.

URTICACEÆ.

ULMUS FULVA, Michx. Fl.
Lowland woods; frequent.

U. AMERICANA, L. Spec.
Lowland woods; abundant.
Woodmen have informed me that formerly the "Hickory-Elm" (probably *U. racemosa*, Thomas) was rather common, but, on account of its valuable timber, has been almost entirely cut away.

CELTIS OCCIDENTALIS, L. Spec. 2d ed.
Woods; infrequent.

CANNABIS SATIVA, L. Spec.
Waste places; frequent.

HUMULUS LUPULUS, L. Spec.
Banks of streams; frequent.

MORUS RUBRA, L. Spec.

Lowland woods; scarce.

Bottom land of Skunk river; Squaw creek, and woods near cemetery (Prof. Pammel).

URTICA GRACILIS, Ait. Hort. Kew.—*U. dioica*, Ait., var. *procera*, Wedd. in DC. Prod. xvi. I.

Lowland woods and waste places; infrequent.

LAPORTEA CANADENSIS, (L.) Gmel. Bot. Voy. Uran. 1826.—*Urtica Canadensis*, L. Spec.

Low woods; frequent.

PILEA PUMILA, (L.) Gray, Man. 1st ed.—*Urtica pumila*, L. Spec.

Lowland woods in moist places: frequent.

PARIETARIA PENNSYLVANICA, Muhl. in Willd. Spec. iv.

Dry banks in woods: not uncommon.

PLATANACEÆ.

PLATANUS OCCIDENTALIS, L. Spec.

Lowland woods: not uncommon.

JUGLANDACEÆ.

JUGLANS CINEREA, L. Spec. 2d ed.

Lowland woods; not uncommon.

J. NIGRA, L. Spec.

Lowland woods; not uncommon.

HICORIA OVATA, (Mill.) Britt. Torr. Bull. xv. 1888.—*Juglans ovata*. Mill. Dict.—*Carya alba*. Nutt. Gen.

Upland woods; abundant.

H. MINIMA, (Marsh.) Britt. Torr. Bull. xv. 1888.—*Juglans alba minima*. Marsh. Arbust.—*Carya amara*. Nutt. Gen.

Lowland woods; abundant.

CUPULIFERÆ.

CORYLUS AMERICANA, Walt. Fl.

Upland woods and thickets; abundant.

OSTRYA VIRGINIANA, (Mill.) Koch, Dendr. ii. 2.—*Carpinus Virginiana*, Mill. Dict. iv.—*O. Virginica*. Willd. Spec. iv.

Upland woods; frequent.

QUERCUS ALBA, L. Spec.

Upland woods: abundant.

A large tree with light colored bark and smooth twigs; leaves obovate, usually nearly equally lobed all around, the sinuses shallow or extending nearly to the midrib.

Q. MACROCARPA, Michx. Hist. Chênes, 1801.

Woods; abundant.

A large tree with deeply furrowed bark and rough or corky-winged twigs, growing more commonly on the bottom-lands; leaves obovate-rhomboidal, usually with the lower half lobed, and the upper half or terminal lobe merely sinuate.

Q. Muhlenbergii, Engelm. Trans. St. L. Acad. iii. 1877.
Des Moines river at Boone (Prof. Pammel. Prof. Budd).

Q. RUBRA, L. Spec.
Upland woods; abundant.

Q. coccinea, Wang. Beitr. 1787.

In the I. A. C. herbarium is a specimen, with acorns, collected by Dr. Bessey, said to come from a tree northwest of the College near the railroad. I have been unable to find the tree, and have not observed the species in the county. It is abundant in the eastern part of the State, where, to a large extent, it replaces *Q. rubra*, and extends at least as far west as Waterloo. The leaf is not to be distinguished from *Q. rubra*, although it is generally more deeply parted; the acorns of the two species are quite different.

SALICACEÆ.

POPULUS TREMULOIDES, Michx. Fl.
Borders of woods; infrequent.

P. GRANDIDENTATA, Michx. Fl.

A few young trees and sprouts were found along the bluffs of Skunk river northeast of Ames. Prof. Budd informs me that formerly it was quite abundant.

P. MONILIFERA, Ait. Hort. Kew.
Lowland woods; not uncommon.

SALIX NIGRA, Marsh. Arbust.
River banks; common.

S. LONGIFOLIA, Muhl. Neue Schrift. Ges. Nat. Fr. Berlin, iv. 1802? (ex Anders. Salic.)
Low, especially sandy ground; common.

S. DISCOLOR, Muhl. l. c.
Low ground; common.

S. HUMILIS, Marsh. Arbust.
Dry hills and copses; frequent.

S. CORDATA, Muhl. N. Berl. Schr. l. c.
Low land; common.

CERATOPHYLLACEÆ.

CERATOPHYLLUM DEMERSUM, L. Spec.
Ponds; becoming scarce.

CONIFERÆ.

(This Order more properly follows *Gramineæ.*)

Juniperus Virginiana, L. Spec.
Along the Des Moines river (Prof. Budd).

HYDROCHARIDACEÆ.

ELODEA CANADENSIS, Michx. Fl.
Ponds; becoming infrequent.

For synonymy see Pringsheim's Jahrbücher, i. p. 499.

Vallisneria spiralis, L. Spec.
Cairo lake.

ORCHIDACEÆ.

Spiranthes cernua, (L.) Rich. Bot. Reg.—*Ophrys cernua.* L. Spec.

Low prairie: infrequent.

Orchis spectabilis, L. Spec.

Springy places in rich woods; scarce.

Woods south of College, and reported elsewhere.

Habenaria bracteata, (Willd.) R. Br. in Ait. f. Hort. Kew.—*Orchis bracteata*, Willd. Spec. iv.

Rich woods; rare.

This species seems to be well distributed over the county, but is usually solitary and only occasionally found.

H. leucophæa, (Nutt.) Gray, Man. 5th ed.—*Orchis leucophæa.* Nutt. Trans. Amer. Phil. Soc. N. S. vii. 1841.

Low prairie: infrequent.

Cypripedium candidum, Muhl. in Willd. Spec. iv.

Low prairie not uncommon.

C. pubescens, Willd. Spec. iv.

Rich woods; infrequent.

Woods west and south of College; on Skunk river, and elsewhere. *C. parviflorum*, Salisb. has been reported, but I doubt if it occurs with us.

C. reginæ, Walt. Fl.—*C. spectabile*, Salisb. Trans. Lin. Soc. i. 1791, (read 1788).—*C. album.* Ait. Hort. Kew.—*C. hirsutum*, Mill. Dict.?

Rich woods: rare.

On the east side of Skunk river north of Ames, a short distance above the ford. This species was formerly much more frequent, but many causes, not the least of which are the ravages of eager students, have almost exterminated this beautiful plant.

IRIDACEÆ.

Iris versicolor, L. Spec.

Marshes: common.

Belamcanda Chinensis, (L.) Adans.—*Ixia Chinensis*, L. Spec.

Occasionally escapes from gardens.

In the absence of sufficient literature I have followed the Manual in the authority for the accepted combination. The New York Catalogue gives *B. Chinensis*, (L.) Redouté.

Sisyrinchium angustifolium, Mill. Dict.

Prairie: abundant.

The white-flowered form is frequent.

AMARYLLIDACEÆ.

Hypoxis erecta, L. Spec. 2d ed. (Syst. Nat. 15th ed. ex Richter.)

Prairie; common.

DIOSCOREACEÆ.

Dioscorea villosa, L. Spec.

Thickets; not uncommon.

LILIACEÆ.

SMILAX HERBACEA, L. Spec.

Moist grassy places; not uncommon.

Var. PULVERULENTA, (Michx.) Gray, Man. 5th ed.—*S. pulverulenta*, Michx. Fl.

Woods; infrequent.

S. HISPIDA, Muhl. Cat. 2d ed.

Rich woods; frequent.

ALLIUM TRICOCCUM, Ait. Hort. Kew.

Rich woods; infrequent.

A. CANADENSE, Kalm, in L. Spec.

Sloughs; frequent.

POLYGONATUM COMMUTATUM, (Schult.) Dietr. in Allg. Gartenz. iii. 1835.—*Convallaria commutata*. Schult. in Roem. & Schult. Syst. vii.—*P. giganteum*. Dietr. l. c.

Asparagus officinalis, L. Spec.

Escapes frequently from cultivation.

SMILACINA RACEMOSA, (L.) Desf. Ann. Mus. Paris, ix. 1807.—*Convallaria racemosa*, L. Spec.

Upland woods; frequent.

S. STELLATA, (L.) Desf. l. c.—*Convallaria stellata*, L. Spec.

Woods; frequent.

Maianthemum Canadense, Desf. l. c.

"Ames. J. C. Noble." Specimen in I. A. C. herbarium.

UVULARIA GRANDIFLORA, Smith, Exot. Bot. p. 99, 1804–1805.

Rich woods; abundant.

ERYTHRONIUM ALBIDUM, Nutt. Gen.

Low woods; abundant.

LILIUM PHILADELPHICUM, L. Spec. 2d ed.

Low prairie; not uncommon.

L. superbum, L. Spec. 2d ed.

A few specimens found at Jewell Junction.

L. CANADENSE, L. Spec.

Low ground; infrequent.

TRILLIUM ERECTUM, L. Spec.

Two specimens (var. *declinatum*) in the I. A. C. herbarium from "Ames". Occasionally reported.

T. cernuum, L. Spec.

A specimen in the I. A. C. herbarium from "Ames."

T. nivale, Riddell, Synops. 1835.

"Boone—Bessey." Specimen in I. A. C. herbarium.

PONTEDERIACEÆ.

PONTEDERIA CORDATA, L. Spec.

Ponds; becoming scarce.

Formerly abundant in the Big Prairie region.

HETERANTHERA GRAMINEA, (Michx.) Vahl. Enum. ii.—*Leptanthus graminea*, Michx. Fl.

Muddy banks of ponds and streams; scarce.

Lake 7 miles southeast of the College; Cairo lake.

COMMELINACEÆ.

TRADESCANTIA VIRGINIANA, L. Spec.

Low ground; frequent.

A white-flowered form was found along the railroad, near the first bridge, going towards Ames.

JUNCACEÆ.

JUNCUS TENUIS, Willd. Spec. ii.

Grassy places; common.

Quite variable in aspect. In dry soil it is low, with few-flowered panicles; in wet places it becomes stouter, often two feet high, with more crowded inflorescence. One form corresponds to "Forma major, floribus subsecundus" of specimens in the Engelmann herbarium. It is not uncommon. Low or, usually, tall; flowers crowded on the inner side of the ascending branches of the panicle, which tends to curve inward at the top.

J. NODOSUS, L., var. MEGACEPHALUS, Torr. Fl. N. Y. ii.

Wet places; abundant.

TYPHACEÆ.

TYPHA LATIFOLIA, L. Spec.

Sloughs and ditches; abundant.

SPARGANIUM EURYCARPUM, Engel. in Gray, Man. 2d ed.

Marshes; frequent.

S. SIMPLEX, Huds. Fl. Angl. 1762.

Marshes; scarce.

Four miles southwest of the College.

ARACEÆ.

ARISÆMA TRIPHYLLUM, (L.) Torr. Fl. N. Y. ii.—*Arum triphyllum*, L. Spec.—*A atrorubens*, Blume, in Rumphia, i. 1835. (Engler, *Araceæ* in DC. Mon. Phan. ii.)

Rich woods; not uncommon.

A. DRACONTIUM, (L.) Schott, Melet. 1832.—*Arum Dracontium*, L. Spec.

Low woods; infrequent.

ACORUS CALAMUS, L. Spec.

Marshes; scarce.

Two miles north of Ames, and elsewhere.

LEMNACEÆ.

SPIRODELA POLYRRHIZA, (L.) Schleid. in Linnæa xiii. 1839.—*Lemna polyrrhiza*, L. Spec.

Bayous and slow-flowing water; not uncommon.

LEMNA TRISULCA, L. Spec.

Ponds; becoming scarce.

This species prefers still water that is filled with vegetation, while *Spirodela* is found also in more open water.

L. MINOR, L. Spec.

Stagnant water; infrequent.

ALISMACEÆ.

ALISMA PLANTAGO, L. Spec.

Wet places; abundant.

SAGITTARIA VARIABILIS, Engel. in Gray, Man. 1st ed.— *S. sagittifolia*, L., var. *variabilis*, Micheli in DC. Mon. Phan. iii. 1881.

In shallow water or wet places; abundant.

We have the three forms known as:—var. *obtusa*, (Willd.) Engel. l. c. 2d ed. (*S. obtusa*, Willd. Spec. iv.), leaves large and broad, obtuse, usually with an abrupt short point, lobes broad and short, flowers diœcious; var. *latifolia*, (Willd.) Engel. l. c. (*S. latifolia*, Willd. l. c.), leaves rather large and broad, obtuse or usually acute, lobes often longer and narrower than in the preceding, flowers monœcious; var. *hastata*, (Pursh) Engel. l.c. (*S. hastata*, Pursh, Fl.), leaves with terminal and basal lobes quite similar in size, long, narrow and acute, flowers monœcious. For notes on these forms see Britton, Torr. Bull. xvii. p. 5, 1890.

S. HETEROPHYLLA, Pursh, Fl.

Muddy shores of ponds; scarce.

Pond northeast of Ames, beyond Skunk river; abundant at Cairo lake.

S. GRAMINEA, Michx. Fl.

Wet places; infrequent.

I have also found what appears to be *S. cristata*, Engel. in Arthur, Contr. Fl. Iowa (Proc. Davenp. Acad. Sci. iv. p. 29, 1886), but more study is needed.

NAIADACEÆ.

Triglochin maritimum, L. Spec.

A single specimen in my herbarium collected by Mr. M. E. Wells in the "forks."

Potamogeton fluitans, Roth. Tent. Fl. Germ. i. 1788.

Streams around Cairo lake.

P. ILLINOENSIS, Morong in Bot. Gaz. v. 1880.

Ponds and lakes; infrequent.

P. HETEROPHYLLUS, Schreb. Spicil. Fl. Lips. 1771.

Ponds; infrequent.

P. lucens, L. Spec.

Sterile specimens, from the pond under the first railroad bridge below the gate, appear to be this species.

P. ZOSTERÆFOLIUS, Schum. Enum. i. 1801.

Lakes and streams; not uncommon.

P. obtusifolius, Mertens & Koch, Deutschl. Fl. i. 1823.

What appears to be this species was found in the pond, under the first railroad bridge, in considerable quantity, but has disappeared.

P. pusillus, L. Spec.

Abundant at Cairo lake.

ZANNICHELLIA PALUSTRIS, L. Spec.
Ponds and slow streams; not uncommon.

NAIAS FLEXILIS, Rostk. & Schum. Fl. Sedin. 1824.
Ponds; becoming scarce.

CYPERACEÆ.

CYPERUS DIANDRUS, Torr. Cat. Pl. N. Y. 1819.
Wet sandy places; scarce.

Var. CASTANEUS, (Pursh) Torr. l. c.—*C. flavescens*, var. *castaneus*. Pursh, Fl.
Wet sands: abundant.

C. ARISTATUS, Rottb. Gram.
Wet sand; not nncommon.

C. SCHWEINITZII, Torr. Cyp.
Sandy soil; frequent.

C. FILICULMIS, Vahl, Enum. ii.
Sandy hills; frequent.

C. ERYTHRORHIZOS, Muhl. Gram.
River banks: abundant.

C. ESCULENTUS, L. Spec.
Low ground; abundant.

C. STRIGOSUS, L. Spec.
Low or sandy ground; abundant.

Var. ROBUSTIOR, Kunth, Enum. ii.
Low ground; common.

ELEOCHARIS PALUSTRIS, (L.) R. Br. Prod. Fl. Nov. Hol. 1810 (by implication).—*Scirpus palustris*, L. Spec.
Wet places; common.

E. ACICULARIS (L.) R. Br. l. c.—*Scirpus acicularis*, L. Spec.
Muddy banks of ponds and streams; common.

SCIRPUS PUNGENS, Vahl, Enum. ii.
Wet clay: scarce.

S. LACUSTRIS, L. Spec.
Sloughs, common.

S. FLUVIATILIS, (Torr.) Gray, Man. 1st ed.—*S. maritimus*, L., var.? *fluviatilis*. Torr. Cyp.
Marshes; infrequent.

S. ATROVIRENS, Muhl. Gram.
Sloughs: common.

ERIOPHORUM LINEATUM, (Michx.) Benth. & Hook. Gen. Pl. iii. 2, 1883.—*Scirpus lineatum*, Michx. Fl.
Wet places; scarce.

Bentham and Hooker by a slip say, "Hic includimus . . . . *E. lineatus*, Mich." Michaux is not really the author of this combination.

E. CYPERINUM, L. Spec. 2d ed.
Wet places; rare.
I have seen the specimens of this, but have none in my possession.

E. POLYSTACHYON, L. Spec.
Low prairie: frequent.

HEMICARPHA MICRANTHA, (Vahl) Britt. Torr. Bull. xv. 1888. — *Scirpus micranthus*, Vahl, Enum. ii. — *H. subsquarrosa*. Nees in Mart. Fl. Bras. ii. 1. 1829.
Wet sand; scarce.

CAREX INTUMESCENS, Rudge, Trans. Linn. Soc. vii. 1804 (read 1803).
Low shady places; common.

C. GRAYII, Carey, Amer. Jour. Sci. iv. 1821.
Low woods; common.

C. LUPULINA, Muhl. in Willd. Spec. iv.
Sloughs.
Prof. Bailey notes one specimen as nearly typical; another as approaching var. *pedunculata*.

C. LURIDA, Wahl. Königl. Ac. Handl. xxiv. 1803.
Sloughs: infrequent.
Prof. Bailey says our specimens are a "depauperate form" of this species.

C. FILIFORMIS, L. Spec.
Swamps; abundant.
Var. LANUGINOSA, (Michx.) B.S.P. Cat.—*C. lanuginosa*, Michx. Fl.—*C. filiformis*, L., var. *latifolia*, Boeck. Linnæa. xli. 1876–7.
Swamps; frequent.

C. TRICHOCARPA, Muhl. in Willd. Spec. iv.
Marshes; infrequent.
Var. IMBERBIS, Gray, Man. 5th ed.
Swamps; common.
Var. LÆVICONICA, (Dewey). — *C. læviconica*, Dewey, Amer. Jour. Sci. xxiv. 1833. — *C. trichocarpa*, Muhl., var. *Deweyi*. Bailey in Bot. Gaz. x. 1883.
Low places; common.
Var. ARISTATA, (R. Br.) Bailey in Bot. Gaz. x. 1883.—*C. aristata*, R. Br. in Narr. Frankl. Exped. app.
Swamps; infrequent.

C. RIPARIA, W. Curtis, Fl. Lond. iv. 1821.
Low places; common.

C. FUSCA, All. Fl. Pedem. ii. 1785.
Grass land; infrequent.

C. STRICTA, Lam. Dict. iii.
Sloughs; common.

C. LONGIROSTRIS, Torr. in Schwein. Ann. Tab. Car. (Ann. N. Y Lyc. i. 1823.)
Shady places; abundant.

C. DAVISII, Schwein. & Torr. Mon. Cyp. 1825.
Wet places; abundant.

C. GRISEA, Wahl. Königl. Ac. Handl. xxiv. 1803.
Grass land; common.

C. LAXIFLORA, Lam., var. LATIFOLIA, Boott, Ill. 1858–1867.
Rich woods; infrequent.

C. TETANICA, Schkuhr, var. MEADII, (Dewey) Bailey, Syn. Car. 1886.—*C. Meadii*, Dewey, Amer. Jour. Sci. xliii. 1842.
Grass land; frequent.

C. EBURNEA, Boott, in Hook. Fl. ii.
Woods; infrequent.

C. PENNSYLVANICA, Lam. Dict. iii.
Dry woods; common.

C. PUBESCENS, Muhl. in Willd. Spec. iv.
Rich woods; not uncommon.

C. CONJUNCTA, Boott, Ill. 1858–1867.
Low grass land; common.

C. GRAVIDA, Bailey, var. LAXIFOLIA, Bailey, Types. Car. 1889.
Low ground; not uncommon.

C. VULPINOIDEA, Michx. Fl.
Low grass land; common.

C. Sartwellii, Dewey, in Amer. Jour. Sci. xli. 1842.
One imperfect specimen, marked by Prof. Bailey, "probably."

C. SPARGANIOIDES, Muhl. in Willd. Spec. iv.
Low ground; common.

C. CEPHALOPHORA, Muhl. in Willd. Spec. iv.
Low ground; frequent.

C. MUSKINGUMENSIS, Schwein. Ann. Tab. 1823.
Sloughs; frequent.

C. TRIBULOIDES, Wahl., var. CRISTATA, (Schwein.) Bailey, Syn. Car. 1886.—*C. cristata*, Schwein. Ann. Tab. 1823.
Low ground, common.

C. STRAMINEA, Willd., var. FESTUCACEA, (Willd.)—*C. festucacea*, Willd. Spec. iv.—*C. straminea*, Willd., var. *brevior*. Dewey. Amer. Jour. Sci. xi. 1826.
Low ground; common.

Var. ALATA, (Torr.) Bailey, Cat. Car. 1884.—*C. alata*, Torr. Mon. Cyp.
Grass land.

GRAMINEÆ.

SPARTINA CYNOSUROIDES, (L.) Willd. Enum. i.—*Dactylis cynosuroides*, L. Spec.
Sloughs; abundant.

Beckmannia erucæformis, (L.) Host, var. uniflorus, Scrib. in Vasey. Desc. Cat. 1885.

Escaped around station-house.

PANICUM GLABRUM, (Schrad.) Gand. Agros. i. 1811.—*Syntherisma glabra*. Schrad. Fl. Germ. 1806.

Roadsides and sandy places: common.

P. SANGUINALE, L. Spec.

Fields: common.

P. PROLIFERUM, Lam. Dict. iv.

Roadsides and cultivated soil; common.

P. CAPILLARE, L. Spec.

Fields: common.

P. VIRGATUM, L. Spec.

Prairie: common.

P. LATIFOLIUM, L. Spec.

Upland woods; frequent.

P. SCOPARIUM, Lam. Dict. iv.

Prairie: common.

One form is nearly smooth except the margins of the leaves; another is stouter, with leaves, sheaths and spikelets hirsute.

P. DICHOTOMUM, L. Spec.

Prairie: common.

P. CRUS-GALLI, L. Spec.

Fields and waste places; common.

Var. MUTICUM, Torr.

Damp places; frequent.

SETARIA GLAUCA, (L.) Beauv. Agrost. 1812.—*Panicum glaucum*, L. Spec.

Fields: common.

S. VIRIDIS, (L.) Beauv. Agrost. 1812.—*Panicum viride*. L. Spec.

Fields; common.

Some specimens with oblong, purplish spikes, are apparently hybrids with *S. Italica*.

S. Italica, (L.) Kunth, Gram. (ex Kunth, Enum. i. 1).—*Panicum Italicum*. L. Spec.

Abundantly escaped.

CENCHRUS TRIBULOIDES, L. Spec.

Sandy soil; not uncommon.

HOMALOCENCHRUS VIRGINICA, (Willd.) Britt. Trans. N. Y. Acad. Sci. ix. 1889.—*Leersia Virginica*, Willd. Spec. i.

Low ground; abundant.

H. ORYZOIDES, (L.) Poll. Enum. Pl. Palat. 1776.—*Phalaris oryzoides*, L. Spec.—*Leersia oryzoides*, Swartz. Fl. Ind. Occ. i. 1797.

Wet places; common.

ZIZANIA AQUATICA, L. Spec.

Ponds; scarce.

South of Shearer School; Onion creek.

ANDROPOGON PROVINCIALIS, Lam. Dict. i.—*A. furcatus*, Muhl. in Willd. Spec. iv.

Prairie; common.

See Hackel, Androp. p. 443; Watson, Contr. Am. Bot. xvii. p. 130 (Proc. Amer. Acad. xxv. 1890).

A. SCOPARIUS, Michx. Fl.

Prairie; common.

CHRYSOPOGON NUTANS, (L.) Benth. Jour. Linn. Soc. xix. 1881.—*Andropogon nutans*. L. Spec. (retained in Hackel. Androp.)

Prairie: common.

Phalaris Canariensis, L. Spec.

Streets of Story City.

P. ARUNDINACEA, L. Spec.

Marshes: infrequent.

ARISTIDA GRACILIS, Ell. Sk. i.

Dry hills: infrequent.

STIPA SPARTEA, Trin. Stipae, 1842.

Prairie; abundant.

ORYZOPSIS MELANOCARPA, Muhl. Gram.

Dry rocky woods; not uncommon.

MUHLENBERGIA SOBOLIFERA, (Muhl.) Trin. Diss. i.—*Agrostis sobolifera*. Muhl. Gram.

Dry hills; infrequent.

M. RACEMOSA, (Michx.) B. S. P. Cat.—*Agrostis racemosa*, Michx. Fl.—*M. glomerata*. Trin. Diss. i.

Dry clay bluffs or wet grassy places; frequent.

M. SYLVATICA, (Torr.) Torr. & Gray, in Gray, Gram. & Cyp. i. 1834.—*Agrostis sylvatica*. Torr. Fl. U. S.

Upland woods: frequent.

M. TENUIFLORA, (Willd.) B. S. P. Cat.—*Agrostis tenuiflora*, Willd. Spec. i.—*M. Willdenovii*. Trin. Diss. i.

Upland woods: not uncommon.

M. DIFFUSA, Schreb. Gram. ii. 1772-1779.

Open lowland woods: abundant.

BRACHYELYTRUM ERECTUM, (Schreb.) Beauv.—*Muhlenbergia erecta*, Schreb. Gram. ii. 1772-1779.—*B. aristatum*, Beauv. Agrost. 1812.—*B. aristosum*, (Michx.) B. S. P. Cat.—*Dilepyrum aristosum*, Michx. Fl.

Rich woods: frequent.

Ours is the form, var. *Engelmanni*, Gray, Man. 5th ed.

PHLEUM PRATENSE, L. Spec.

Meadows and pastures; common.

Sporobolus vaginaeflorus, (Torr.) Vasey, Desc. Cat. 1885.—*Vilfa vaginæflora*. Torr. in Gray. Gram. & Cyp. i. 1834.

Sandy and sterile soil.

S. ASPER, (Michx.) Kunth, Gram. i. (ex Enum. i.)
Sandy soil; common.

S. HETEROLEPIS, Gray, Man. 1st ed.—*Vilfa heterolepis*, Gray, in Ann. Lyc. N. Y. iii. (read Dec. 1834).
Prairie; abundant.

S. CRYPTANDRUS, (Torr.) Gray, Man. 1st. ed.—*Agrostis cryptandrus*, Torr. in Ann. Lyc. N. Y. i. 1824.
Sandy hills; infrequent.

AGROSTIS ALBA, L. Spec.
Meadows; common.

Var. VULGARIS, (With.) Thurb. in Watson, Bot. Calif. ii. 1880. —*A. vulgaris*, With. Eng. Bot. 1776.
Moist meadows; common.

A. PERENNANS, (Walt.) Tuckerm. Amer. Jour. Sci. xlv. 1843.—*Cornucopiæ? perennans*. Walt. Fl.

A. HYEMAL, (Walt.) B.S.P. Cat.—*Cornucopiæ hyemalis*, Walt. Fl. —*Agrostis scabra*, Willd. Spec. i.
Prairie, especially in open or barren spots; common.

CINNA ARUNDINACEA, L. Spec.
Upland woods; abundant.

CALAMAGROSTIS CANADENSIS, (Michx.) Beauv.—*Arundo Canadensis*, Michx. Fl.—*Deyeuxia Canadensis*, Hook. Arc. Pl. 1862.
Sloughs; abundant.

CALAMOVILFA LONGIFOLIA, (Hook.) Scribn. in Hackel, True Grasses. 1890.—*Calamagrostis longifolia*. Hook. Fl. ii.—*Ammophila longifolia*. Benth.
Dry hills; infrequent.

BOUTELOUA HIRSUTA, Lag. Elench. v.? 1816 (ex Kunth, Enum. i.)
Dry hills; infrequent.

B. CURTIPENDULA, (Michx.) Gray, Man. 3d ed. (or earlier?)—*Chloris curtipendula*, Michx. Fl.—*B. racemosa*. Lag. Varied. Cienc. 1805 (ex Kunth, Enum. i.)
Prairie; common.

PHRAGMITES VULGARIS, (Lam.) B.S.P. Cat.—*Arundo vulgaris*, Lam. Fl. Franc. iii. 1778.—*P. communis*, Trin. Fund. 1820.
Ponds; frequent.

KŒLERIA CRISTATA, (L.) Pers. Syn. i.—*Aira cristata*, L. Spec.
Prairie; abundant.

EATONIA OBTUSATA, (Michx.) Gray, Man. 3d ed. 1857 (or earlier). —*Aira obtusata*, Michx. Fl.
Prairie; abundant.

E. PENNSYLVANICA, (Spreng.) Gray, Man. ed. of 1857 (or earlier?). —*Aira Pennsylvanica*. Spreng. Act. Petrop. 1810.
Sloughs; abundant.
It also occurs in upland woods, where it is low and slender.

ERAGROSTIS HYPNOIDES, (Lam.) B. S. P. Cat.—*Poa hypnoides*, Lam. Ill. i.—*E. reptans*, Nees. in Mart. Fl. Bras. i. 1829.
Banks of streams; common.

E. MAJOR, Host, Gram. iv. 1809.—*Poa Eragrostis*, L. Spec.
Fields and roadsides; common.

E. FRANKII, Meyer, Ind. Sem. Hort. Petrop. —?
River banks; scarce.

E. PURSHII, Schrad. in Linnæa, xii. 1838.
River banks and roadsides; common.

E. pectinacea, (Michx.) Gray, Man. ed. of 1857 (or earlier?).—*Poa pectinacea*, Michx. Fl.
"Ames-Bessey." A young, unnamed specimen; but evidently it belongs here.

DIARRHENA DIANDRA, (Michx.).—*Festuca diandra*, Michx. Fl. —*D. Americana*, Beauv. Agrost. 1812.
Woods; frequent.

DACTYLIS GLOMERATA, L. Spec.
Pastures; freely escaped from cultivation.

POA COMPRESSA, L. Spec.
Wet or dry soil; common.

P. SEROTINA, Ehr. Gaud. Agrost. i. 1811 (ex Kunth, Enum. i.)
Wet places; frequent.

P. PRATENSIS, L. Spec.
Pastures and meadows; common.

GLYCERIA NERVATA, (Willd.) Trin. Act. Petrop. S. 6, i. 1831?.—*Poa nervata*, Willd. Spec. i.
Wet places: abundant.

G. FLUITANS, (L.) R. Br. Prod. i. 1810.—*Festuca fluitans*, L. Spec.
Ponds and sloughs; infrequent.

FESTUCA OCTOFLORA, Walt. Fl.—*F. tenella*, Willd. Enum. i.
Dry hills: frequent.

F. NUTANS, Willd. Enum. i.
Upland woods; abundant.

F. SHORTII, Kunth,(?) Vasey, Descr. Cat. 1885.
Sloughs; rare.

A small quantity found about 3 miles east of Ames. It seems quite distinct from *F. nutans*. The spikelets are more numerous, the panicle more or less drooping, but the branches not reflexed in fruit as in the case of *F. nutans*. This appears in Wood's Class-Book, edition of 1861, p. 794, as *F. Shortii*, Kunth, and is placed under *F. nutans*.

BROMUS KALMII, Gray, Man. 1st ed.
Dry ground; infrequent.

B. secalinus, L. Spec.
Waste places; scarce.

B. CILIATUS, L. Spec.
Woods; abundant.
Var. PURGANS, (L.) Gray, Man. 1st ed.—*B. purgans*, L. Spec.
Upland woods; abundant.
Apparently a distinct species, flowering a month earlier than *B. ciliatus*.

Lolium perenne, L. Spec.
Waste places; rare.
Var. ITALICUM, Vasey, Desc. Cat. 1885.
Escaped around the station-house.

AGROPYRUM REPENS, (L.) Beauv. Agrost. 1812.—*Triticum repens*, L. Spec.
Fields and waste places; frequent.
The form which has passed for *A. glaucum*, Roem. & Schult., is occasionally found.

HORDEUM JUBATUM, L. Spec.
Waste places: common.

ELYMUS VIRGINICUS, L. Spec.
River banks; abundant.
Specimens frequently occur which appear to be hybrids with *E. Canadensis*.

E. CANADENSIS, L. Spec.
River banks; abundant.
Var. GLAUCIFOLIUS, (Muhl.) Gray, Man. 5th ed.—*E. glaucifolius*, Muhl. in Willd. Enum.
Gravelly places; frequent.
Var. GLABRIFOLIUS, Vasey, Contr. Nat. Herb. (No description.)
Rocky places; frequent.

E. STRIATUS, Willd. Spec. i.
Upland woods; frequent.

ASPRELLA HYSTRIX, (L.) Willd. Enum.—*Elymus Hystrix*, L. Spec.
Woods; abundant.

EQUISETACEÆ.

EQUISETUM ARVENSE, L.
Sandy soil; common.

FILICES.

ADIANTUM PEDATUM, L. Spec.
Rich woods; abundant.

PTERIS AQUILINA, L. Spec.
Rich woods; scarce.

ASPLENIUM FILIX-FŒMINA, (L.) Bernh. N. Jour. f. d. Bot. ii. 1806.—*Polypodium Filix-femina*, L. Spec. 2d ed.
Shady ravines; abundant.

CYSTOPTERIS FRAGILIS, (L.) Bernh. l. c. i. 1805.—*Polypodium fragile*, L. Spec. 2d ed.
Woods; common.

ONOCLEA SENSIBILIS, L. Spec.
Wet places; not uncommon.

OSMUNDA CLAYTONIANA, L. Spec.
Woody ravines; scarce.

Botrichium Virginianum, (L.) Swartz, Jour. f. d. Bot. ii. 1800.—*Osmunda Virginiana*. L. Spec.—*B. Virginicum*, Willd. Spec. v.
Rich woods; scarce.

LIST OF THE MORE IMPORTANT WORKS REFERRED TO IN THE CATALOGUE, PRECEDED BY THE ABBREVIATIONS USED.

Ait. Hort. Kew.: Aiton, W.—Hortus Kewensis, 3 vols. 1789; 2d ed. Aiton. W. T. (Ait. f.), 5 vols. 1810.

Bigel. Fl. Bost.: Bigelow, J.—Florula Bostonensis, 1814; 2d ed., 1824; 3d ed., 1840

B. S. P. Cat.: Britton, N. L., Sterns, E. E., and Poggenburg, J. F.—Preliminary Catalogue of Anthophyta and Pteridophyta, * * * within 100 miles of New York City, 1888.

Darl. Fl. Cest.: Darlington, W.—Florula Cestrica, 1826; 2d ed., Flora Cestrica, 1837; 3d ed., 1853.

DC. Prod.: DeCandolle, A. P. and A.—Prodromus Systematis Naturalis Regni Vegetabilis. i, 1824; ii, 1825; iii, 1828; iv, 1830; v. 1836; vi. 1837; vii, 1, 1839; vii. 2, 1838; viii, 1844; ix, 1845; x, 1846; xi, 1847; xii, 1848; xiii, 1, 1852; xiii, 2, 1849; xiv, 1856; xv, 1, 1864; xv, 2, 1866; xvi, 1, 1869; xvi, 2, (p. 1–160) 1864; xvi, 2 (p. 161–end), 1868; xvii, 1873.

DC. Syst.: DeCandolle, A. P.—Regni Vegetabilis Systema Naturale. i, 1818; ii, 1821.

Ell. Sk.: Elliott, S.—A Sketch of the Botany of South Carolina and Georgia. i, 1821; ii, 1824.

Gray, Man.: Gray, Asa—Manual of the Botany of the Northern United States. 1848; 3d ed.(?) 1857; 5th ed., 1867; 6th ed., 1890.

Gray, Syn. Fl.: Gray, Asa—Synoptical Flora of North America; i. 2, 1884; ii, 1, 188; Suppl, 1 886.

Hook. Fl.: Hooker, W. J.—Flora Boreali-Americana. i. Pt. 1, 1829; i. Pt. 2 & 3, 1832; ii. 1840. (Ex notes in Dr. Engelmann's copy.)

Kunth, Enum.: Kunth, K. S.—Enumeratio Plantarum omnium hucusque cognitarum. i, 1833; Suppl., 1835; ii, 1837; iii, 1841; iv, 1843.

Lam. Dict.: De la Marck, J. B.—Encyclopédie Méthodique. i, 1783; ii. 1786; iii. 1789; iv, 1797; v, (vols. v to xiii by J. L. Poiret.) 1804; vi 1804; vii, 1806; viii & ix, 1810; x, 1811; xi, 1813; xii, 1816; xiii, 1817.

Lam. Ill.: De la Marck, J. B.—Tableau Encyclopédique et Méthodique des trois règnes de la Nature. Botanique. Illustration des Genres. i. 1791; ii. 1793; iii & Suppl. (Poiret), 1823.

L. Mant.: Linnæus, C.—Mantissa Plantarum, p. 1 to 142, 1767; Mantissa Plantarum altera, p. 143 to 588. 1771.

L. Spec.: Linnæus, C.—Species Plantarum. 1753; 2d ed. i. 1762; ii. 1763; 3d ed., 1764 (said to be the same as the 2d edition).

Marsh. Arbust.: Marshall, H.—Arbustrum Americanum. 1785.

Michx. Fl.: Michaux, F. A.—Flora Boreali-Americana. 2 vols. 1803.

Mill. Dict.: Miller, P.—The Gardener's Dictionary, 8th ed., 2 vols., 1768. (The first edition in which binomials are used.)

Muhl. Cat.: Mühlenberg, H.—Catalogus Plantarum Americæ Septentrionalis hucusque cognitarum, 1813; 2d ed., 1818. (The one usually quoted.)

Muhl. Gram.: Mühlenberg, H.—Descriptio uberior Graminum et Plantarum Calamarium Americæ Septentrionalis. 1817.

Nutt. Gen.: Nuttall, T.—The Genera of North American Plants. 2 vols. 1818.

Pers. Syn.:—Persoon, C. H.—Synopsis Plantarum, i, 1805; ii. 1807.

Poir.: Poiret, J. L.—See Lam. Dict. & Ill.

Pursh, Fl.: Pursh, F.—Flora Americæ Septentrionalis, 1814 (another issue in 1816).

Torr. Cyp.: Torrey, J.—Monograph of North American Cyperaceæ (Annals Lyc. Nat. Hist. N. Y. iii. 1836).

Torr. Fl. N. Y.:—A Flora of the State of New York. 2 vols. 1843.

Torr. Fl. U. S.:—A Flora of the Northern and Middle Sections of the United States, 1824.

Torr. & Gray, Fl.:—A Flora of North America. i, p. 1 to 184, July 1838; i, p. 185 to 360, Oct. 1838; i, p. 360 to end, June 1840; ii, p. 1 to 184, 1841; ii, p. 185 to 392, spring, 1842; ii, p. 393 to end, Feb. 1843 (ex notes in Dr. Engelmann's copy).

Trin. Diss.: Trinius, K. B.—De Graminibus unifloris et sesquifloris. Dissertatio botanica, 1824.

Vahl, Enum.: Vahl, M.—Enumeratio Plantarum. i, 1804; ii, 1806.

Walt. Fl.: Walter, T.—Flora Caroliniana. 1788.

Willd. Enum.: Willdenow, K. L.—Enumeratio Plantarum horti regii botanici Berolinensis. 1809.

Willd. Spec.:—Linnæus, Species Plantarum. i, Pt. 1, 1797; i, Pt. 2, 1798; ii, 1799; iii, Pt. 1 (p. 1–848), 1800; iii, Pt. 2, (p. 849–1474), 1801; iii, Pt. 3, 1803 (subsequent to Michaux's Flora); iv, Pt. 1, 1805; iv, Pt. 2 1807; v, 1810.

Transformations of a Carabid (Plochionus timidus), *and observations on a Coccinellid enemy of the red spider.*

By J. C. Duffey.

(Presented October 20th, 1890.)

Among the many insect pests that damage the foliage of our forest and shade trees, the fall web-worm (*Hyphantria cunea*, Drury) is probably one of the worst. It not only destroys the foliage, but covers the tree with its web, making a very ugly sight. The great damage done by this insect gives us a special interest in its enemies. Charles V. Riley mentions* the following insect enemies of *H. cunea:* External—*Mantis carolina*, *Prionidus cristatus*, *Euchistus servus*, and *Poidesus spinosus*. True parasites—*Telenomus bifidus* (an egg-parasite), *Metorus hyphantriæ*, *Apanteles hyphantriæ*, *Limneria pallipes*, and *Tachina*, sp.

At the Missouri Botanical Garden, during the present season, three other enemies of *H. cunea* have been observed: one of the jumping spiders (Aranidæ), the larva of a lace-wing fly (*Chrysopa*) feeding on both eggs and larvæ, and a beetle, *Plochïonus timidus*, Hald. The life-history of the latter is of interest not only on account of its preying upon one of our worst tree-defoliators, but also as the life-history of no species in this genus has hitherto been described, while it has been traced for comparatively few of the Carabid beetles.

June 9, webs of *Hyphantria cunea* began to appear on various trees in the Garden. One of the colonies was given to one of the garden pupils, Mr. James Dunford, with instructions to rear the insects. Mr. Dunford soon found that the larvæ were disappearing, and, on examining the web, discovered several small black larvæ of some unrecognized Carabid, which were evidently the cause of the trouble, and afterward proved to be *Plochionus*

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* Report of Entomologist, U. S. Dept. Agr. for the year 1886. Reprinted in Bull. No. 10, Div. Entomology, 1887.

timidus. Other webs were then examined for this insect, and from two to twenty larvæ were found in nearly every web, where they were also observed feeding on the larvæ of *H. cunea*. In many webs the *Hyphantria* larvæ were greatly diminished in numbers, and occasionally a web was found entirely uninhabited. On the 24th of June. a web of *H. cunea* was found in which were only 18 larvæ of the web-worm, but which contained an equal number of the predaceous larvæ. June 25, seven-tenths of all webs found contained larvæ of *P. timidus*. June 28, very few webs of *H. cunea* were found, and most of them were uninhabited. Where the web-worms were found, the larvæ of *P. timidus* were also invariably present. By July 1, the *Hyphantria* larvæ had disappeared.

Two beetles of *P. timidus* were found in a web of *H. cunea* in the breeding-cage on July 7th, and one flew into Mr. Dunford's window on the evening of July 31st, probably attracted by the light.

The second brood of web-worms began to appear July 22d. On the 5th of August, adults of *P. timidus* were observed in the webs, and new larvæ of this species were found three days later. Aug. 6, forty-eight webs were cut from mulberry-trees and carefully examined. Besides the *Hyphantria* larvæ, the following insects were found: *P. timidus*, 8 beetles and 7 larvæ; 7 *Chrysopa* larvæ; 5 spiders; and 1 adult Coccinellid.

A careful search was made about this time for the eggs of *Plochionus*. Aug. 11, Mr. Dunford found, in a web of *H. cunea*, a small white foreign egg. Having seen one, it was not difficult to find others, and thirty-two eggs were found in the portion of a web covering a single mulberry leaf. Aug. 18, other eggs of *P. timidus* were found in a web of *H. cunea*. These eggs must have been laid several days after the hatching of the *Hyphantria* eggs, as they were distributed through a portion of the web covering several mulberry leaves, and the *Hyphantria* larvæ must have been feeding for some time to have extended their web so far. Aug. 29th, half-grown larvæ, full-grown larvæ, and the imago of *P. timidus* were found in *Hyphantria* webs. The last *Plochionus* larva found in a web was discovered Sept. 4. This larva pupated Sept. 11, and on the 24th had assumed the form of the imago, but still within the pupa case.* Aug. 9, eight of the supposed eggs of *P. timidus* were placed in a web of *H. cunea* on a cutting of mulberry, which was set in moist sand in a six-inch pot, and covered with a bottle from which the bottom had been removed, a piece of muslin being tied over the mouth of the bottle. One egg hatched during the day, and four more during the following night. The young larvæ, which were evidently the same as those observed in the webs, began feeding on the *Hyphantria* larvæ soon after coming from the egg, Aug. 16, three of these larvæ were alive and in fine condition. All moulted during the night of Aug. 15. This was probably the second moult, the first moult not having been observed, for there is very little difference in the appearance of the larva before and after moulting, the only means of being sure of the time of moulting being to find the cast skin, which is a difficult task when the larvæ are in the webs.

From the 16th to the 17th of the month the larvæ grew rapidly. They had now reached nearly full size, and very little change took place in them during the next two days, although they thickened up a little and showed more white between the dorsal plates. Aug. 21, one was removed from the cage to be sketched. They had now stopped feeding, and during the next three days they dug into the sand somewhat. During this time one of them died. Aug. 24, the remaining larva took a position on the inner side of a leaf that lay on the sand and remained in this position for two days, pupating on the 26th, thus completing the larval state in sixteen days. The pupa was apparently normal, but, being used to sketch from, was injured and died.

Aug. 5, a web of *H. cunea*, in which were several *Plochionus* larvæ, was placed in a pot of sand and covered with a one-gallon bell-jar having an open top over which a piece of muslin was tied, and mulberry leaves were daily placed in the jar as food for the web-worms. These leaves were soon covered by their web, after which the larvæ ate all of the enclosed leaves excepting the midrib and larger veins. Other larvæ of *P. timidus* were placed in the jar from time to time, and seemed at home in this web

* This specimen did not succeed in freeing itself from the pupa case, and died in a few ays.

and grew well, but no very close observations could be made on them on account of the mass of leaf-remains spun together, in which they concealed themselves. However, some of the larvæ were in sight most of the time until Aug. 15, when none could be seen. On taking out the web, which peeled off in layers, nine pupæ and two larvæ of *P. timidus* were found. One of the larvæ pupated the next day, and the perfect beetle emerged Aug. 26. The other larva pupated Aug. 19, and the perfect beetle emerged Aug. 28.

To determine whether the *Plochionus* larvæ normally pupate in the webs, as would appear from this observation, on the 20th of August a branch of Osage orange, on which was a colony of *H. cunea* accompanied by five larvæ of *P. timidus*, was brought in and placed uncovered in a pot of sand, thus leaving the larvæ at liberty to escape if they were so inclined. Aug. 27th, a pupa was found, suspended in the web, swinging free from the foliage as if in a hammock. Sept. 4th, this pupa changed to a beetle. The web was then examined for indications of the other larvæ, and two additional beetles and one dead pupa were found in the web, leaving but one of the original five larvæ unaccounted for.

In order to observe more closely the moults, eggs were placed in deep cells on glass slides. One egg hatched in a cell Aug. 10. The larva was kept in the cell and fed on small *Hyphantria* larvæ. This larva ate and grew well for a time. It moulted Aug. 13, after which time it ate well for a few days and then sickened and died, perhaps because of its close quarters. Another larva, that came from the egg Aug. 11, was transferred to a small covered salt-cellar. This larva grew as well as those in the breeding cages. It moulted Aug. 15. There was very little change in the appearance of the larva after moulting; it then grew gradually, and moulted again Aug. 19, after which it grew rapidly, reaching about full size Aug. 24. It was quiet Aug. 28, as if about to pupate; but next morning it had escaped, the glass cover having in some way been moved a little to one side, making room for its exit. This larva should have pupated Aug. 27 to have given it the same length of time in the larval state as the one before mentioned. These facts would indicate the number of moults to be three: one on the third or fourth day, the second four days later, and the third at the time of pupating, nine days later.

While I did not succeed in rearing perfect insects from the eggs found in *Hyphantria* webs, there is no doubt that the larvæ hatched from the above eggs were identical with those found in the webs, and from which adults of *Plochionus timidus* were reared.

I have not been able to determine the state in which this insect hibernates. These observations seem to indicate that it passes the winter as an imago, as all of the observed larvæ of the second brood either reached that state or died. While some of the larvæ dug somewhat into the sand before pupating, they did not pupate there; and those that were left undisturbed in the web were not observed to leave it. The larvæ which were seen to dig into the sand were disturbed daily by removing the debris left by the web-worms so that the *Plochionus* larvæ might be more closely observed. This is also probably the reason that all of the larvæ hatched from eggs did not go through all of their transformations, since of those brought in with the webs and not disturbed in the breeding-cage by removing any of the web, nearly all reached the imago state. There may be another brood than those studied, which might hibernate as pupæ, provided the species has other food habits than those observed; but it is not possible for another brood to have reached the pupal state in the *Hyphantria* webs. Six beetles of the sceond brood, kept in a breeding-cage with web-worms, died without laying eggs. If *Plochionus* has no other prey, it is strange that its transformations should have so long escaped observation, since the web-worm and its enemies have received considerable attention.* Yet this may be due to the local or temporary rarity of this insect at the time the published observations were made.†

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* See Riley, 3 Mo. Report; and Report of Entomologist for 1886.

† The morning after this paper was presented to the Academy I received a letter from Miss Mary E. Murtfeldt of Kirkwood, Mo., who is interested in economic entomology, and whose attention I had called to this insect early in the season with a view of learning if she had made any observations on it, from which I quote the following:—

"Had you not discovered this valuable little Carabid, I should have done so, as it appeared in Kirkwood on the second brood of *Hyphantria cunea*, and in many instances depopulated the webs. Small as they are, I have seen these larvæ seize hold of an almos full-grown worm and not let go for all the contortions of the latter. I have also found them

Plochionus timidus is originally described by S. S. Haldeman* as follows:—

P. timidus.—Dull reddish-brown above; antennæ, legs, lower surface and lateral margins of prothorax and elytra, testaceous; elytra wide, deeply striate, interstices convex. 8 mill. long.

It is redescribed by Dr. Horn† as follows:—

P. timidus, Hald. — Very similar in form and color to *pallens*. The thorax rather shorter, the sides more arcuate, the hind angles more sharply rectangular. The tarsi are slender cylindrical, not flattened or sulcate above, the unguis with longer pectination. L. .28–.30 in; 7–7.5 mm. Male anterior tarsi narrowly dilated, the first three joints biseriately squamulose beneath, middle tarsi less dilated, first joint hairy beneath, the next three squamulose, anal segment bisetose each side. Female tarsi slender, anal segment with three or four setæ each side.—Pa. to Tex. and Cal.

The following descriptions of the earlier stages are drawn from a few of the many specimens observed by msyelf during the past summer:—

Newly hatched larva 3 mm. long, colorless, tapering from the head, with 13 segments exclusive of head. Ninth abdominal segment with a pair of 4-jointed cerci. Antennæ, cerci, and body, sparingly pilose.—Described from three living specimens.

Full-grown larva 10 to 15 mm. long, wider at metathorax, the number of segments unchanged. Head somewhat chitinized, light brown. Body segments with chitinized dorsal plates deepening in color to the abdomen, where they are black. Meso- and meta-thoracic segments with one small ventral and four lateral plates each. Abdominal segments with four small lateral and five ventral plates each, the latter confluent on the last three segments. Cerci of 9th segment 5-jointed. Unchitinized parts pale, the dorso-lateral plates visible from above.—Described from one living and five alcoholic specimens.

Pupa 5–6 mm. long, white and soft, distinctly showing the members of the imago; sparingly beset with spreading rusty hairs. Head inclined

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destroying the larvæ of two or three species of Tortrix and Tineid larvæ which web the leaves of oaks in the autumn. I have no doubt it will prove to be one of the most useful of predaceous insects, and I congratulate you on your discovery.

"I do not think it has appeared much to the east of St. Louis, as the ravages of the web-worm in some parts of Illinois and through portions of Indiana as I passed in August last exceeded anything that I had previously seen. No mention of the Carabid was made at the meetings of the Entomological Club."

* Proceedings of the Academy of Natural Sciences of Philadelphia, vol. i p. 289.

† Amer. Entom. Soc. x, 1883, p. 145.

against the ventral surface of thorax; eyes prominent, black; antennæ partly concealed ventrad by pro- and meso-thoracic legs. Metathoracic legs covered to the tarsi by the inflexed wings.—Described from three living specimens.

Another garden and green-house pest—one to be especially dreaded in dry, hot seasons—is the little mite *Tetranychus telarius*, popularly known as the red spider. This little pest has been apparently almost free from insect enemies, so far as I can learn; the only one published being an undescribed species of the genus *Thrips*, mentioned by Mr. Theodore Pergande (Psyche, iii. 1882, p. 381). Mr. Howard tells me that "Professor Riley's unpublished notes state that a species of *Diplosis* feeds in the larval state upon these mites."

Three insects have been observed to feed on red spiders at the Botanical Garden this season: *Thrips 6-maculata*, Pergande, (ms.),*

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* This is the species mentioned by Mr. Pergande in Psyche, and of which he kindly sends me the following description:

"*Thrips 6-maculata*, n. sp.—Length of ♂, 0.6–0.8 mm.; ♀, about 1 mm. Polished. Color pale yellow, the head almost white, the thorax darkest, the prothorax often more or less distinctly marked with four small dusky spots and two oblique stripes; frequently the anterior margin of the pterothorax, its disk, and a spot near the base of all the wings, are also dusky, and also more or less of the anterior margin of the abdominal segments. The legs are usually pale yellow with only the tip of the tarsi blackish, though now and then a specimen may be met with the apex of the femora dusky and with a pale dusky spot in front and behind, at base of anterior and median tibiæ. Antennæ rather short, either pale dusky, with only the two basal joints pale yellowish, or joints 3–5 whitish, with only the apex dusky and the last three joints blackish. Joints 3–5 subequal in length, the fourth almost globular, the sixth longest and longer than the two last ones combined. Head small, scarcely twice as long as the eyes, and provided with two long, backward-curved bristles in front of the posterior ocelli. Eyes brown, prominent, large, globular, and coarsely granulated. Ocelli colorless or reddish. Prothorax longer than wide and well separated from the pterothorax, narrowest in front, not or scarcely wider than the head, its posterior angles broadly rounded and the surface quite coarsely wrinkled transversely; it is provided at the anterior angle with a long, stout, pale bristle and a small hair near it, with two similar long bristles, curved gently backward at the posterior angles, and two bristles which cross each other at the posterior margin. Abdomen smooth with segments 3–7 furnished at the posterior angle with a rather long bristle, and 6-8 similar bristles fringing the remainder of the body. Wings narrow, shorter than the body, colorless or faintly yellowish, with the veins pale dusky; the anterior pair being ornamented with three more or less distinct or well-defined dusky spots, of which the terminal one forms usually a band. One of them is placed at the inner side near the base; the second one, often elongated, in front of the middle; and the third at about the apical third of the wing. Both veins unite in the region of the median spot, and continue as a single vein to the base of the wing, and are sparsely beset with long and stiff bristles. Fringes pale dusky, stiff, and rather sparsely distributed, being more dense and longer along the posterior edge.—Found on many different plants infested with red spider, on which it has repeatedly been observed to feed.—This may probably form a new genus."

the larvæ of a lace-wing fly (*Chrysopa*),* and a little beetle *Scymnus punctum*.

The present season, on account of the dry weather, has been very favorable for the increase of the red spider; but these three insects, of which the little beetle has been the one most important, have kept it so well under control that it has done very little damage.

The larva of *S. punctum* was first observed on Aug. 7 on *Morus rubra*. The red spider was well distributed over the leaves of this plant, but had not become so bad as to do serious damage. The *Scymnus* increased rapidly and was soon found in all stages. The mites soon began to decrease, so that on Aug. 23 none could be found on the mulberry trees. On Aug. 29, neither *Scymnus* nor mites could be found in the mulberry grove. About the same state of affairs was repeated on the lindens (*Tilia*). Red spiders have usually been very bad on *Manihot utilissima* and *Ficus Parcelli*, and attacked these plants badly early in the present season. Aug. 16, *S. punctum* was found in all stages on the plants, increasing so rapidly that the mites soon began to decrease in numbers, and by the last of August were not numerou senough to do much damage to the plants. These mites next appeared on the moon-vines (*Ipomea bona-nox*) in great numbers. The little beetle soon followed, and, finding such an abundance of food, increased rapidly. There are now (Sept. 24th) very few of the mites on these vines, and *Scymnus* is decreasing in numbers.

This Coccinellid beetle apparently goes through all of its transformations on the plant on which its food is found, but I have not found the egg, and hence cannot give the number of moults nor the length of the larval state. In instances where I have had opportunity to observe it, the pupal state lasted four to five days. I have seen a half dozen of these pupæ attached to a single leaf of the moon-vine. I have bred no parasites from this beetle, and only in one instance have I observed any enemy to attack it; this

* I have seen one of these larvæ devour 110 of the mites at a single meal and it was still eating when I left it on account of darkness. Next day a full-grown web-worm was placed in the box in which this larva was confined. The ravenous little fellow soon attacked the web-worm, thrusting its long mandibles into the posterior segment of the web-worm, which remained quiet for some time; but finally, bringing its head around, grasped its tormentor by the thorax with its mandibles and crushed it to death.

was the larva of *Chrysopa*, before mentioned as feeding on the red spider, and which I also observed destroying a pupa of our little *Scymnus*.

The beetle when first excluded is nearly white, but soon assumes the dark color characteristic of it. The original description of the imago is as follows:—

*Scymnus punctum.**—On account of its size and form it resembles the preceding (*S. nanus*). but the coarsely punctured thorax distinguishes it. Rounded oval. convex. shining black. covered with fine and sparse pubescence. Head obsoletely punctulate, antennæ yellow. Thorax finely and sparsely punctured at the middle. coarsely and densely at sides. base margined. obtuse in the middle. subsinuate each side. Elytra finely and sparsely punctured. Body beneath coarsely punctured. abdominal plates smooth, punctured at base. considerably shorter than the segment. not extending laterally to the parapleuræ. Feet testaceous-yellow, four posterior thighs piceous. .05 in. long.

Although the transformations of other species have been described, I append descriptions of the larva and pupa of *S. punctum* as they were observed at the Garden.

Full-grown larva 2.5 mm. long. salmon-colored to dark sooty brown, with 13 segments exclusive of head. Thoracic segments with two dorsal rows of low, broad elevations, pilose. with many black dots and blotches. Abdomen with four longitudinal rows of tubercles. brown-pilose from numerous black dots; the anal segment paler, without tubercles, and used as a proleg.—Described from six living specimens.

Pupa 2 mm. long. showing the members of the beetle. tapering from base of thorax so as to be triangular in general outline; from salmon-colored becoming dark brown, the wings and thorax darkest; sparingly covered with spreading hairs which usually bear near their ends small globules of what appears to be a liquid. Anal segment covered by the cast larval skin. by which the pupa is suspended.—Described from six living specimens.

In closing, I wish to acknowledge the kindness of the Entomologists of the Division of Entomology at Washington, and of Prof. A. J. Cook and Prof. J. H. Comstock, who have aided me by the identification of species and looking up literature to which I did not have access. I am also indebted to Prof. Wm. Trelease for many hints.

The drawings were made under my direction by Mrs. Maggie H. Duffey.

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* Le Conte, Proc. Acad. Phil. vol. vi, p. 141.

EXPLANATION OF PLATES.

PLATE X.

Plochionus timidus, Haldeman.

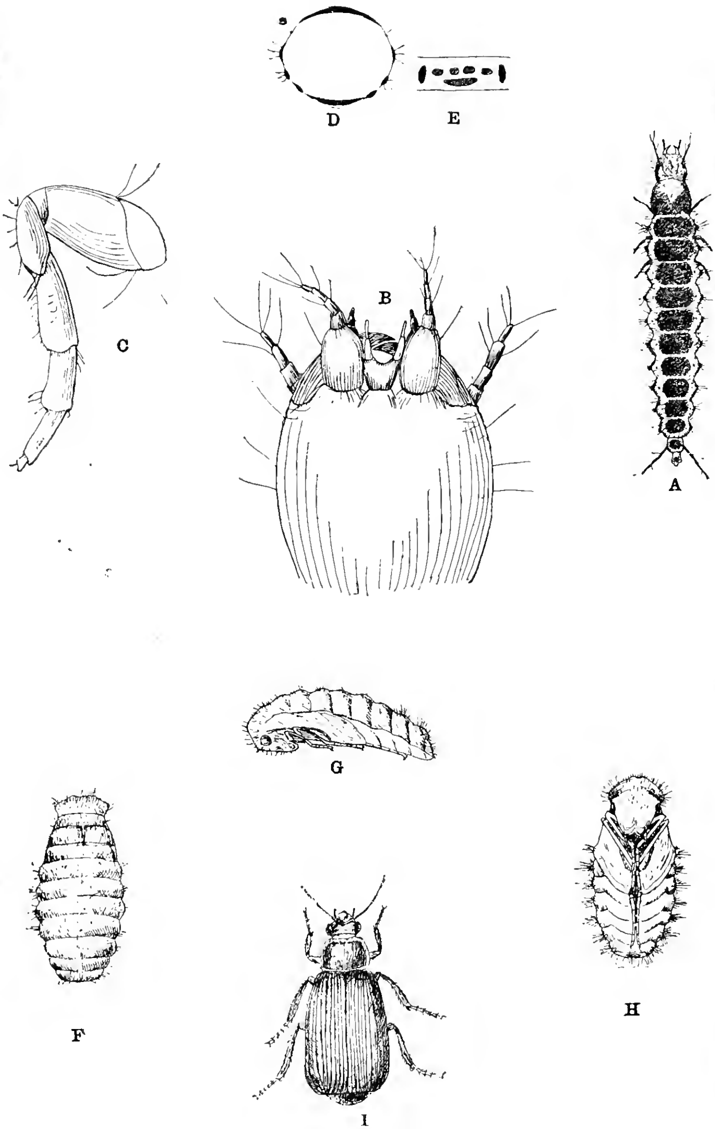
A. — Full-grown larva × 4.
B. — Head of same, ventral view × 25.
C. — Leg of same × 25.
D. — Diagram showing arrangement of plates on abdomen; S. spiracles.
E. — Diagram showing four ventral and two latero-ventral plates.
F. — Pupa, dorsal view × 4.
G. — Pupa, side view × 4.
H. — Pupa, ventral view × 4.
I. — Imago × 4.

PLATE XI.

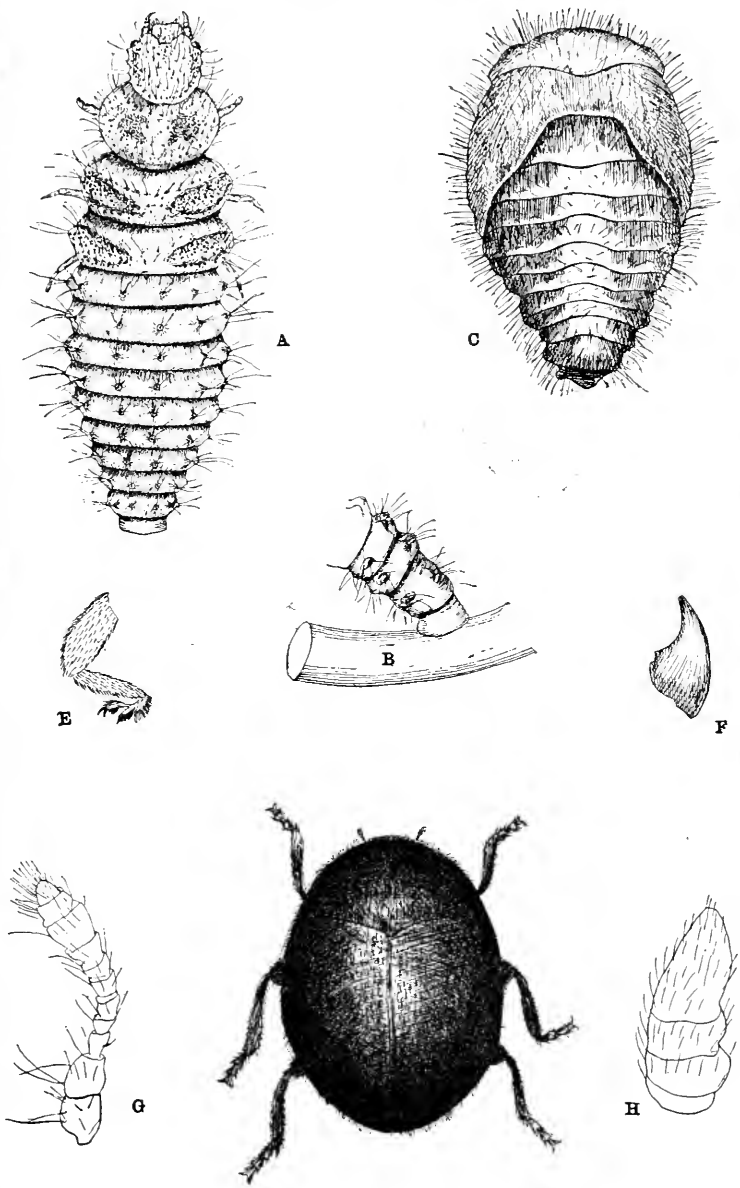
Scymnus punctum, Lec.

A. — Larva × 25.
B. — Last four segments of same, lateral view × 25.
C. — Pupa, dorsal view × 25.
D. — Imago × 25.
E. — Leg of same × 25.
F. — Mandible of same × 25.
G. — Antenna of same × 25.
H. — Maxillary palpus of same × 25.

PLOCHIONUS TIMIDUS.



SCYMNUS PUNCTUM.



CONTRIBUTIONS FROM THE SHAW SCHOOL OF BOTANY.

No. 8.

On the Seed-Coats of the Genus Euphorbia.

By L. H. Pammel.

(Presented January 5th, 1891.)

To systematic botanists this genus offers many difficulties, and, though elaborated by careful and painstaking workers, the obstacles have not been entirely removed. Who has not been perplexed by *E. maculata* and *E. humistrata?* The work of Trécul and others on the stems of many plants,* of Engelmann on the leaves of Conifers, &c., has shown that it may be possible to utilize histological characters in classification, while it is always well enough to show some of these even if they are not directly useful in this way. It was for the latter reason that this work was undertaken during a short vacation spent in St. Louis a year since, though I had at the same time a hope that something might be learned of use in systematic botany. Owing to other labors, I have not been able to present my paper earlier, (although the work was substantially completed before my return from St. Louis), but a short account of the results was given at the Indianapolis meeting of the American Association in August last.[1] I am under obligation to Professor Trelease for the use of some authentic seeds from the Engelmann herbarium and for other favors, and to Mr. A. S. Hitchcock for a few seeds. My drawings were transferred to stone by Miss Hoke and Mr. Griffiths. To each I express my thanks.

It is well known that the character of the seed is used to separate some of the species of *Euphorbia.* Thus in *E. polygonifolia* and *E. Geyeri* the seeds are smooth and even. In *E. maculata* and *E. glyptosperma* they are minutely roughened. In *E. hexagona* they are tuberculate. While these external dif-

* Ferd. Pax has published an extended paper on the Anatomy of Euphorbiaceæ: Die Anatomie der Euphorbiaceen in ihrer Beziehung zum System derselben. Separate from Engler's Botanische Jahrbücher, vol. v., p. 384–421, Pl. vi. & vii.

1. Read before Section F.

ferences are marked in some species, more differentiation also occurs in the minute structure. To what extent this may be used in the determination of the species, will be seen from the description of the species themselves.

It has been claimed that the minute structure of many seeds is so characteristic that a study in this direction would greatly aid in the discrimination between related species. Artificial classifications on this basis are very useful so far as they go. They may be used with advantage in the separation of important Orders, as Harz[2] and others have shown. A knowledge of the structure of seeds has enabled botanists in many cases to detect the adulterations of various agricultural and garden seeds, and the impurities of drugs and articles of food, and artificial classifications will enable one, with some precision, to locate the Order of the plant from which the impurity has been derived.

Considerable work has been done by various botanists in working out the structure of the seed-coats of many Orders, so that the question whether the seed-coats offer microscopic characters sufficiently distinct to separate species can now be answered very satisfactorily. The Order Leguminosæ more than any other has been studied with a view to determine the interesting points about the structure of the seeds, especially the Malpighian cells,[3] which are nearly always present. I have examined the seeds of a large number of North American and other genera; the Malpighian cells are present in all of the genera with the exception of *Arachis*. In this genus the light line is absent and the cells are not much longer than broad. Different genera show, of course, great difference in the length of these cells. This would naturally depend on the size of the seed itself. The cells of the second layer show greater variation.

H. Godfrin,[4] who wished to determine the systematic value of seed-coats, has given us the results of his investigation. He exam-

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2. Harz: Landwirthschaftliche Samenkunde, 2 vols., Paul Parey, 1885, vol. ii. p. 555.

3. O. Mattirola (La linea lucida nelle cellule malpighiani degli integumenti seminali.—Mem. della R. Acc. delle Sci. di Torino, Ser. ii., vol. xxxvii.)—Solla (Just. Bot. Jahresbericht, 1885, p. 825), calls attention to the fact that Targioni Tozzetti, in 1854, named these "Malpighian cells." (Saggio di studi intorno al gascio dei Semi., Torino, 1854.) They should therefore bear the name of Malpighi, who first observed them.

4. Etude histologique sur les teguments seminaux des angiosperms, Nancy, 1880, pp. 112, 5 Plates. A, Peter, Just. Bot. Jahresbericht 1880, p. 137.

ined the seed-coats of the following Orders: *Juncaceæ*, *Liliaceæ*, *Iridaceæ*, *Alismaceæ*. *Betulaceæ*, *Cupuliferæ*, *Juglandaceæ*, *Leguminosæ*, *Rosaceæ*, *Granateæ*, *Rhamnaceæ*, *Cucurbitaceæ*, *Araliaceæ*, *Caryophyllaceæ*, *Nymphæaceæ*, *Ranunculaceæ*, *Magnoliaceæ*, *Berberidaceæ*, *Papaveraceæ*, *Fumariaceæ*, *Ampelideæ*, *Celastraceæ*, *Sapindaceæ*, *Linaceæ*, *Ilicineæ*, *Plantaginaceæ*, *Caprifoliaceæ*. As a result of his work he concludes that little aid can be obtained from such studies. He states that the seed-coats of closely related genera and species differ but little. In some suborders like *Magnolieæ* and *Iliceæ* of the *Magnoliaceæ*; and *Sileneæ* and *Alsineæ* of the *Caryophyllaceæ*, sufficient structural differences occur to separate them.

Ewald Bachman,[5] in his excellent paper on the development and structure of the seeds and the seed-coats of *Scrophulariaceæ*, considers the microscopic structure of the seeds of only conditional value from a systematic standpoint. It is true he says that in the section *Cymbalaria* of the genus *Linaria* the seeds are provided with reticulated thickenings (netzfaserschicht) found in no other seeds of the genus, but the same structure again occurs in other genera not closely related, where the dehiscence and structure of the capsule is the same as in *Pentstemon digitalis*. *Buddleieæ* is clearly separated from all other tribes of the *Scrophulariaceæ*, yet the seed-coats do not differ in any marked degree from those of *Pedicularis palustris*.

The seed-coats of *Euphorbiaceæ* have been studied but little, and those of *Euphorbia* still less. Gris,[6] who studied the development of the seeds in *Euphorbia*, found two seed-coats present. Poisson[7] made more extended study of the seed-coats of *Euphorbiaceæ*. He finds that different species and genera differ greatly in regard to the number of layers of cells found in the outer and inner seed-coat. Several genera of *Euphorbiaceæ* have been the subject of exhaustive treatises; thus *Ricinus* has been stu-

5. Die Entwickelungsgeschichte und der Bau der Samenschalen der Scrophularineen. Inaugural Dissertation (separate from K. Leop.-Carol. Acad. der Naturforscher, vol. xliii. Halle, 1880, 4 Plates), pp. 179.

6. Ann. Sci. Nat. Ser. 4, vol. xv. No. 1, p. 1; vol. xvii., 1862, p. 315.

7. Bull. Soc. Bot. de France, 1878, p. 47.

died by Treviranus,[8] Bischoff,[9] Brongniart,[10] Harz,[11] Wiesner,[12] and Flückiger & Hanbury.[13]

Aleurites has been studied by Wichmann,[14] *Jatropha curcas* has been studied by Hanausek,[14a] and *Croton sebiferum*[14b] by Morel.

A study of the seed-coats of the genus *Euphorbia* has brought out a wholly unlooked for feature, namely, the presence of mucilaginous walls with spirals, in the seeds of some of the species. This seems not to have been observed before, although Harz[15] doubtfully refers to mucilage in the third layer of the outer cell-coat in *E. Lathyris*.

A few words about the literature concerning mucilage in the seeds of various genera will not be out of place, as it is of such common occurrence. This substance occurs in Orders in no way related, as in *Rosaceæ* (*Pyrus* [*Cydonia*] *vulgaris*), *Cruciferæ* (*Brassica*, *Lepidium*, *Teesdalia*, &c.), *Linaceæ* (*Linum*), *Plantaginaceæ* (*Plantago*), *Polemoniaceæ* (*Polemonium*, *Collomia*), *Acanthaceæ* (*Acanthodium*, *Ruellia*), &c.

In 1855 Cramer[16] made a valuable contribution, from a chemical as well as a microscopical standpoint, on the subject of mucilage in the seeds of *Linum* and *Cydonia*. Kützing[17] had also previously studied them. The seeds of quince have long been

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8. Wie entsteht die sogenannte Oberhaut der Samenschale (Testa seminis?). Sitz. d. K. Bayr. Akad. d. Wissenschaften zu München, Jahr. 1863, vol. ii.

9. Handbuch der Bot. Terminologie, i. 1833, Plate xliii, Figs. 1872 and 1873A.

10. Ann. Sci. Nat., 1st Series, vol. xii. p. 268.

11. L. c. p. 833, Fig. 48.

12. Rohstoffe des Pflanzenreiches, p. 721.

13. Pharmacographia: A History of the principal Drugs of Vegetable Origin met with in Great Britain and British India. London: Macmillan & Co., 1879, p. 565–69.

14. Anatomie des Samens von Aleurites triloba, Forst. Verhandl. d. Zoolog.-Botan. Gesellschaft, Vienna, 1879, p. 411; E. Pfitzer, Just, Bot. Jahresb. 1880, p. 35; Bot. Centralblatt, vol. i., 1880, p. 486.

14*a*. Anatomischer Bau der Samen von Jatropha Curcas, L. (Curcas purgans, Endl.) Zeitschr. des Allg. Oester Apotheker Vereins, 1878, p. 173.

14*b*. Contribution à l'etude de la graine du Croton sebiferum. Nancy, (Crepin Leblond), 34 pp.; Just, Bot. Jahresb. 1886, p. 911.

Flückiger Just Bot. Jahresb. 1878, p. 1121.

15. L. c., p. 832.

16. Ueber das Vorkommen und die Enthstehung einiger Pflanzenschleime.—Pflanzenphysiologische Untersuchungen von Carl Nägeli und Carl Cramer, 1855, Heft iii. Plates xxvii.-xxxiv. p. 32. See Plate xxviii., f. 1–10.

17. Grundzüge der Philosophischen Botanik, Cydonia, Plate iv., Figs. 4–6.

used in medicine for the mucilage.[18] Cramer also studied the seeds of *Plantago Psyllium*; later the seeds of this genus were studied, chemically and histologically, by Uloth[19]. In various systematic works reference is usually made to the presence of mucilage in the seed-coats of *Linum usitatissimum*, and the mucilaginous cells of this species have been studied quite extensively from a chemical and histological standpoint.[20]

Brassica, *Lepidium*, and other *Cruciferæ*, have been studied both chemically and histologically by Abraham,[21] Frank,[22] Schroeder,[23] Sempolowski,[24] Hofmeister,[25] Höhnel,[25a] Nobbe,[25b] Berg,[25c] &c.

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18. Flückiger & Hanbury, p. 269.

19. Ueber Pflanzenschleime und seine Entstehung in den Samenepidermis von Plantago maritima und Lepidium sativum, Flora 1875, pp. 193-409, Pl. iv.

20. Cramer, l. c.

W. Hofmeister. Ueber die zu Gallerte aufquellenden Zellen der Aussenfläche von Samen und Perikarpien. Berichte der K. Sächs. Gesellsch. der Wissenschaften. Sitzung am 20 Februar 1858, 37 pp. 1 plate.

Wiesner. Rohstoffe des Pflanzenreichs, p. 723.

Harz, l. c. p. 952.

Flückiger und Hanbury, l. c., p. 98.

Schimper, A. F. W. Anleitung zur Mikroskopischen Untersuchung der Nahrungs-und Genussmittel, Jena, 1886, G. Fischer; pp. 140 and 79 wood-cuts. See pp. 79, 94, 98, 110; Figs. 52, 58, 74.

Moeller, Josef. Mikroskopie der Nahrungs-und Genussmittel aus dem Pflanzenreiche, Berlin, Julius Springer, 1886; p. 173, Figs. 144, 145.

Hanausek, T. F. Die Nahrungs-und Genussmittel aus dem Pflanzenreiche, Berlin, Kassel, 1884, pp. 485, 100 wood-cuts. Vol. v. of Allgemeine Waarenkunde und Rohstoffe.

Luerssen, Chr. Handbuch der Systematischen Botanik. Vol. ii. Phanerogamen, Leipzig, H. Haessel, pp. 1229. See p. 642.

Klenke Illustrirtes Lexikon der Verfälschungen der Nahrungsmittel und Getränke, etc.; 2nd edition, pp. 750. 424 Figs. Leipzig, 1879. See p. 389-393, Figs. 222, etc.

21. Bau und Entwickelungsgeschichte der Wandverdickungen in den Samenueberhaut-zellen einiger Cruciferen. Inaugural Dissertation. Separate from Pringsheim's Jahrbücher für wissenschaftliche Botanik, vol. xvi., p. 599.

22. Ueber die Anatomische Bedeutung und die Entstehung der vegetabilischen Schleime. Pringsheim's Jahrbücher für wissenschftliche Botanik, 1866, vol. v., p. 161.

23. Untersuchung der Samen der Brassica Arten und Varietaten. Landwirtschaftliche Versuchs, Station, vol. xiv., 1871, p. 179.

24. Ueber den Bau der Schale landwirtschaftlich wichtiger Samen. Landw. Jahrbücher, vol. iii., p. 824-866, plate vii. Beiträge zur Kenntniss des Baues der Samenschale. Inaugural Dissertation, 3 lithographic plates, 60 pp., Leipzig, 1874.

25. L. c.

25*a*. Bau der Samenschalen der cultivirten Brassica-Arten. Wissenschaftliche praktische Untersuchungen auf dem Gebiete des Pflanzenbaues. Fr. Haberlandt, vol. i. p. 171.

25*b*. Handbuch der Samenkunde, p. 72.

25*c*. Anatomischer Atlas zur pharmaceutischen Warenkunde, Berlin, 1865, p. 92, Pl. xlvi., Fig. 124.

The subject of mucilage elsewhere in the tissues of various plants cannot be discussed here. It will be sufficient to refer to a few papers from which the literature can be obtained.[26]

The uncoiling of spirals in some seeds, on the addition of water, is of less common occurrence. The appearance is so remarkable and interesting that many observers have turned their attention to the subject. Spirals were first observed in the seeds of *Casuarina* by Robert Brown;[27] later he also found them in the seeds of one of the orchids, *Renanthera coccinea*. The appearance is thus described by him:

"The fibrillæ in their natural state exhibit, in most cases, hardly any indication of spiral structure: but the membrane, of which they entirely consist, is sufficiently elastic to admit of being extended, and at the same time unrolled to about twice the length of the tube. They then form a broad ribbon of equal width throughout, and spirally twisted from right to left—a direction opposite to that which generally obtains in spiral vessels."

In 1828 Lindley[28] observed the swelling and spirals in the seeds of *Collomia linearis*. As this paper is ordinarily not accessible, I will quote from it:

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26. Flückiger and Hanbury, l. c., p. 92.

For the mucilage in the tissues of *Althæa* and other *Malvaceæ*, see:—

Link u. Schweigger's Journal, vol. xiii., p. 186.

Schmidt: Ueber Pflanzenschleim und Bassorin,—Ann. d. Chem. u. Pharm., 1844, p. 53–54.

Kützing, l. c., p. 195.

Wigand: Ueber die Deorganisation der Pflanzenzelle,—Pringsheim's Jahrbücher, vol. iii. p. 149.

Shultz: Die Natur der lebendigen Pflanze. Berlin, 1823, p. 671.

For the mucilage in the tubers of orchids see Schmidt, l. c., p. 179; Kützing, l. c., p. 194; Cramer, l. c., p. 149; Flückiger & Hanbury, p. 656.

For mucilage in the rhizome of *Symphytum officinale* see Kützing, p. 194; Cramer, l. c., p. 8.

For mucilage in *Cactaceæ* see Cramer, l. c, p. 8.

In the leaves of *Barosma*, and other plants, mucilage occurs. For references see Flückiger, Schweizerische Wochenschrift für Pharmacie, 1873, p. 435; Flückiger & Hanbury, l. c, 109; Radlkofer, Sapindaceen Gattung Serjania, Munich, 1875, p. 100; DeBary, Comparative Anatomy of the vegetative organs of the Phanerogams and Ferns, Eng. translation, Bower & Scott, Oxford, 1884, p. 73.

Good general accounts of mucilages and gums are given by Flückiger and Tschirch (English translation by Prof. Power). The Principles of Pharmacognosy. New York, Wm. Wood & Co., 1887, p. 163–70.

Valenta: Die Kleb—eund Verdickungsmittel. Cassel, 1884.

Giraud: Compt. Rend. vol. lxxx., p. 477.

Husemann & Hilger: Die Pflanzenstoffe, vol. i., 1882, p. 131.

(*Note 26 continued on next page. See also Nos. 27 and 28.*)

Collomia linearis. — "The genus *Collomia*, like several other genera of *Polemoniaceæ*, is remarkable for a mucous matter in which the seeds are enveloped: if the seeds are thrown into water, this mucus instantly dilates and forms around them like a cloud, and in a short time acquires a volume greater than that of the seed itself. Upon examining the cause of this singular phenomenon, it will be found to depend upon the presence of an infinite multitude of exceedingly delicate and minute spiral vessels, lying coiled up, spire within spire, on the outside of the testa; when dry, these vessels are confined upon the surface of the seed by its mucus, without being able to manifest themselves; but the instant water is applied the mucus dissolves, and ceases to counteract the elasticity of the spiral vessels, which then dart forward at right-angles with the testa, each carrying with it a sheath of mucus, in which it for a long time remains enveloped, as if in a membranous case. This observation is particularly interesting, inasmuch as spiral vessels are, we believe, now for the first time seen upon the external surface of a vegetable organ; they have been hitherto supposed to exist solely within the substance of plants, accompanying either the medullary sheath, or the veins which diverge from it—with one or two exceptions, of which the seeds of *Casuarina* is one."

Lindley[29] further says about *Collomia heterophylla:*

"It offers what seems to be an explanation of the nature of the supposed spiral vessels in the testa of *C. linearis*. Its testa is in like manner mucilaginous, and, if examined with a high magnifier, is seen to be covered with an entangled mass of hairs, held together by the mucilage, and evidently analogous to the coma of some plants, but most particularly to those hairs that cover the surface of certain of the Convolvulus tribe, to which *Polemoniaceæ* have a strong affinity."

Mr. Richard Kippist[30] in an excellent paper has called attention to the presence of spiral cells in the seeds of some of the *Acanthaceæ*. In *Acanthodium spicatum* it is thus described:

The seed "is of lenticular form, covered, especially towards the margin, with whitish hairs, which are closely appressed to the surface, and glued together at their extremities, so as rather to resemble corrugations of the testa than distinct hairs; on being placed in water, however, they are set at liberty, and, expanding on all sides, are seen to consist of fascicles of long, cylindrical, transparent tubes, firmly cohering for about

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Behrens: The Microscope in Botany. English translation by N. B. Hervey, Boston, 1885, p. 327–367. This work contains an excellent bibliography.

27. Miscellaneous Works, vol. i, No. 549.

28. Edwards' Botanical Register, vol. xiv. (1828), No. 1166.

29. Edwards' Botanical Register, vol. xvi. (1830), No. 1347.

30. "On the existence of Spiral Cells in the Seeds of Acanthaceæ." Transactions of the Linnæan Soc., vol. xix., p. 65. Read March 17, 1840.

one-third of their length, and presenting all the characters of spiral vessels. These fascicles usually contain from five to twenty tubes; each tube inclosing one, two, or occasionally even three spiral fibres, which adhere closely to the membrane."

It may be well in this connection to quote from Dr. Gray:[30a]

"The 'mucilage' so copiously developed on the surface of the seed when immersed in water, and which gave name to the genus, consists of innumerable and most delicate diaphanous tubes, which lengthen wonderfully when wetted. The spiral thread which they contain (on which account they were confounded with 'spiral vessels,' and which uncoils as the tube softens or dissolves into jelly) is wanting in one species, namely, *C. gracilis*. In this and in the several following species, the mucilage cells are beneath a more or less evident pellicle or epidermis, composed of fragile tabular cells. which are thrown off when the former develop and protrude under moisture. But this pellicle is not obvious in the typical species."

The fruits of some of the *Labiatæ* are also provided with mucilaginous epidermal cells which produce spirals on being moistened with water. These have been studied by Schleiden,[31] Nägeli,[32] Schenk,[33] Hofmeister,[34] Frank,[35] Harz,[35a] Balfour,[36] &c.

In some of the species of the genus *Salvia*, as in the subgenus *Echinosphacea*,[36a] the nutlets are abundantly mucilaginous. Schenk, however, finds that in *Lavandula*, *L. Stæchas* is provided with epidermal cells which swell in the presence of water, while *L. Spica* does not. The same is true of *Plectanthra glaucocalyx* and *P. parviflorus*. Other genera of *Labiatæ* provided with these structures are *Ocimum*, *Dracocephalum*, *Calamintha*, *Melissa*, *Plectranthus*, and *Lallemantia*. Lessing[37] found that the hairs on the achenes of some *Compositæ* are provided with mucilaginous spirals. They have also been the subject of a paper by Macloskie.[37a]

30a. Proceedings of the American Academy, viii., 1870, p. 258.
31. Beiträge zur Botanik, Leipzig, 1849, p. 137.
32. Ueber den innern Bau vegetabilischer Zellenmembranen. Sitzungsberichte der K. bayr. Akad. d. Wissenschaften zu München, 1864, vol. ii., Heft ii., pp. 114–170, 3 plates. See p. 114–123, Pl. 1.
33. Zur Kenntniss des Baues der Früchte der Compositen und Labiaten. Bot. Zeit., 1877, p. 409–415. E. Loew. Just Bot. Jahresb. 1877, p. 320, 321.
34. L. c., p. 26–27.
35. L. c., p. 169, 170, 171.
35a. L. c., p. 867, 868.
36. Class-Book of Botany. Edinburgh, 1871, p. 19.
36a. Gray: Synoptical Flora of North America, vol. ii., p. 366.
37. See Kippist, l. c., p. 65.
37a. "Achenial Hairs and Fibres of Compositæ," Am. Naturalist, vol. xvii. pp. 31–36.

The chemistry of mucilages and gums is a subject still open for investigation, especially in regard to the transitional stages. Behrens[38] has divided all vegetable mucilages into — I. Characteristic Mucilage: I. *a.* Mucilage from cellulose, as in roots of *Symphytum; b.* Mucilage from starch, as in orchid bulbs.—II. Amyloid.—III. Lichenin.—IV. Gum Mucilage.

Giraud[39] has grouped these substances in the following manner:

I. Ordinary varieties of gum; arabin, bassorin, cerasin.
II. Pectose: gum tragacanth (adragantin.)
III. Plant mucilages in a more restricted sense.
  1. Insoluble in alkalies and dilute acids. (The cellulose of quince mucilage.)
  2. Insoluble in alkalies, and forming with acids glucose and a variety of dextrin. (Flax-seed and mucilage of Irish moss.)
  3. Soluble in hot concentrated alkalies, and converted by acids into dextrin and glucose.

Mucilage, which is an isomer of cellulose and bears the formula $C_6 H_{10} O_5$ or $C_{12} H_{20} O_{10}$, in some cases is derived from the walls of cells which originally consisted of cellulose, but are gradually transformed by a process of degeneration into mucilage. In some cases, at least, it seems to be derived from the starch granules, which are very common in the cells of seeds just before they are ripe, as in *Plantago Psyllium*, *Linum*, *Pyrus vulgaris*, &c.[40] In others both sources can be recognized.

Behrens says:

"In a general way it may be said that all mucilage gives a blue-violet and sometimes a yellow color with iodine, and with oxalic-nitric acid; that the gums give no color with iodine, but are transformed into mucic acid by nitric acid."

Some are precipitated by normal acetate of lead, while others are precipitated only by basic acetate. Some mucilages are colored red by rosolic acid, which color is not readily removed by alcohol. This is true especially where the mucilage does not result from

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38. Behrens, l. c.

39. Compt. rend. vol. lxxx. p. 477. See Flückiger und Tschirch., Engl. translation, p. 164.

40. Behrens, l. c., p. 371.

the breaking up of the cell-wall. Hanstein's aniline[41] mixture colors characteristic mucilage red with a tinge of purple. Coraline gives to the mucilage derived from starch a red color which is not removed by boiling in alcohol. Gums do not color by rosolic acid.[42]

Microchemical tests have been made by Nägeli[43] and Hofmeister[44] on the spirals of *Salvia Hormium.* The swollen portion of the fruit of *Salvia* is colored blue on the addition of iodine water and iodine alcohol. When the iodine and sulphuric acid are of certain concentration it always becomes blue. In *Salvia Hormium* this substance was blued by the presence of iodine, but it becomes reddish on the addition of sulphuric acid. The thread remains uncolored. *Teesdalia nudicaulis* behaves in the same way. Iodine and sulphuric acid color the mucilaginous cell-walls of *Linum usitatissimum* blue.

Frank,[45] who has given us an exhaustive study of the microchemical reactions for a large number of mucilaginous seeds, pericarps, and tissues, concludes that this substance is either cellulose or gum. It is gum (in part, the gum and mucilage of Behrens) in the epidermal cells of the seeds of *Linum* and *Plantago.* It is derived from the secondary membrane of the cell-wall. In the tissues of *Malvaceæ* it is also derived from the cell-wall. The mucilage found in the parenchyma cells of *Symphytum* is a gum, and is derived from cellulose. The gum of *Cycadaceæ*, *Marattiaceæ* and *Tilia* is derived from the substance in the intercellular passages. The mucilage in the cells in tuberous-rooted orchids is derived from the starch of the cell-contents.

In *Salvia sylvestris* iodine causes no change, but iodine and sulphuric acid color not only the mucilaginous cell-sheath, but the spiral band, a deep blue. The mucilage of quince-seeds, *Ocimum basilicum*, *Ruellia*, and others, is related to it.

Hofmeister[46] says that the mucilaginous substances in the seeds of *Collomia*, *Acanthodium*, *Ruellia*, *Teesdalia*, *Pyrus*

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41. Hanstein, Ueber d. Organe der Harz-und Schleim-Absonderung in den Laubknospen. Bot. Zeit. 1868. p. 700, &c.

42. Behrens, l. c., p. 328, 367; Goodale, Physiological Botany, p. 51, 99; Flückinger & Tschirch, Pharmacognosy, Engl. translation, p. 169; Frank. Jour. für Pract. Chem., vol. xcv. p. 479, &c. &c.

43. L. c., p. 119.

44. L. c., p. 30.

45. L. c., p. 197, 198.

46. L. c., p. 29.

(*Cydonia*) *vulgaris*, *Linum*, and other cases mentioned by him, agree in the chemical reactions with the substance of the cell-wall.

Cramer was of the opinion that the mucilage in *Linum* is a transformed product of the starch-grains contained in the epidermal cells. Hofmeister considered that this substance was contained in the outer membrane of the epidermal cells, and in its chemical behavior resembled the mucilage of the quince. The mucilage of flax is insoluble in cupra ammonium, but the *Plantago* mucilage is readily soluble in that substance. Uloth[47] extracted the mucilage of 150 seeds of *Plantago*, and only obtained 0.045 per cent. of mucilage. The extracted mucilage again swells in the presence of water. Alcohol precipitates it, and microchemical tests show that the substance has not been changed by separation. Iodine and chloriodide of zinc, or iodine and sulphuric acid, do not cause any change.

Abraham[48] says in regard to the reaction of the mucilaginous cells in *Cruciferæ*: "The substance is insoluble in water, soluble in potash; and iodine and sulphuric acid cause the usual reaction."

The *Euphorbia* mucilage seems to be related to that of *Ruellia*, *Linum*, *Ocimum*, *Salvia*, &c.

I have taken up only the species of *Euphorbia* of the new edition of Gray's Manual.[49] Only six of the twenty-seven sections established by Boissier[50] occur within the limits of the Manual, while only eight occur in the United States, according to Dr. Engelmann.[51]

Anisophyllum is represented by nine species in the new Manual. The seeds, with the exception of *E. Preslii*, are ash-colored, while those of the latter are blackish. The different sections are readily separated by seed characters. These are shown on plate xii., figures 1–9. The white outer part which covers the seeds of some of the species is smooth and shining. An examination of ripe seeds will show that in many cases, as in *E. polygonifolia*, this part has been removed so that some appear brown.

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47. L. c. 48. L. c.

49. Watson & Coulter: Gray's Manual of the Botany of the Northern United States, Revised edition, 1890, p. 452.

50. DeCandolle: Prodromus, vol. xv. II, p. 8.

51. On the genus Euphorbia: Amer. Jour. of Sci., Ser. 2, vol. xxxiv.; Engelmann Reprint, p. 441–445.

Cross-sections of the seeds are shown on Pl. xii., p. 568, figs. 1, 2. and 7. As the seeds are extremely hard and brittle, they were placed in water for a time; in that way it was thought good sections could be obtained. An examination of such material showed that the white portion was transformed into a mucilaginous substance. Dry sections were then cut and mounted in water, then examined. The outer cells are colorless and clearly stratified; they are rounded out, and under the influence of water elongate, becoming much longer than a cross-section of the seed itself. In a surface-view these cells are prismatic in outline. Some microchemical tests were made with the following results:—A section was placed in alcohol, and potassium iodide was added. The outer cells began to lengthen out, otherwise no change could be observed; but on addition of sulphuric acid the cell-walls and the spirals became violet, changing to blue. In no case did the iodine act on the cell-walls before the addition of the acid.

The palisade-like cells are present in all of the species studied; in some they are less developed. as in *E. polygonifolia*. Between the palisade tissue and the outer colorless cells a granular layer occurs; this is present in all of the species abounding in mucilage, indicating that it has some connection with the formation of this substance. The outlines of these cells are difficult to make out. On the addition of iodine the granules color blue. In *E. Geyeri* another layer of polygonal cells is found underneath the palisade-like cells of the inner seed-coat. They are radially elongated cells with thin walls. This layer in both species is very much compressed. In *E. Geyeri* the pores in the palisade cells are somewhat more pronounced.

The general outline of the seeds of the next section is shown on Pl. xii., figures 5–9. They are wrinkled and more or less pitted The seeds of *E. serpyllifolia*. *E. glyptosperma*, *E. maculata*, *E. humistrata*. are ash-colored, while in *E. Preslii* they are blackish. As in the last section, the outer row of cells is mucilaginous with the exception of *E. Preslii*. already referred to. This character is well developed in *E. serpyllifolia*, and somewhat less so in *E. glyptosperma*. nevertheless easily seen. It is less developed in *E. maculata* and *E. humistrata*.

The roughening of the seeds in *E. serpyllifolia* and *E. glyp-*

tosperma is due to the outer row of cells, which are more or less arranged like papillæ, as is shown in figure 1, plate xiii. The cells in both cases are plainly stratified before the addition of water. On the addition of water these cells immediately elongate as shown in figure 13*a*. Stratification is well preserved in sections mounted in glycerine jelly. Microchemical tests were not made.

Underlying the outer row of cells the granular layer occurs. On the addition of iodine the granules color blue, showing the presence of starch. The palisade-like layer is not so well developed in these species. It is followed by several layers of thin-walled elongated cells. Above the palisade-like layer a row of thin-walled cells occurs.

In *E. maculata* the walls of the outer cells are of darker color, and the granular layer is not so pronounced. The palisade-like cells resemble those of the other species. *E. humistrata* is much like *E. maculata*. In *E. Preslii* the outer layer of cells is not colorless as in the other species.

E. hexagona, which is the only representative of *Zygophyllidium* in the region covered by the Manual, has tuberculate seeds. In some cases the seeds are covered with an ashy substance; in others, they are of a darker color. A section through a seed shows that the ridges are produced by large cells which project out as shown in plate xiii., figure 10, more magnified at fig. 10 *B*. Sometimes only a single cell occupies this ridge, in other places two or more may be found. In the depressed portions of the seed the mucilaginous cells are less developed. (See fig. 10 *C*.) The cell-walls in all these cases are plainly stratified before the addition of water; on the addition of water, the cells immediately elongate. (See fig. 10 *ba'*.) In the depressed portions the cell-cavity is small, and contains a brown substance. On addition of iodine the colorless cell-walls do not change, but when sulphuric acid was also added they became blue. The granular layer is well developed underneath the mucilaginous cells. On addition of iodine the granules color blue. The palisade-layer is made up of three parts, a lower and an upper, separated by an intermediate portion. In these the cells are rounded and somewhat elongated. The palisade-like cells are very thick, and, unless a good section is obtained, the structure is not readily made out. The pores of these cells are well developed, as shown in the figure. Following this layer are radially elongated cells with thin walls. Next to the endosperm is a layer of cells which resemble the thickened cross-bars or spiral bands found in the aërial roots of many orchids like *Oncidium*, *Cattleya*, *Stanhopea oculata*, *Dendrocolla teres*, *Vanda furva*.[52] They likewise resemble the thickened bars found in the anther walls of some *Liliaceæ*, &c.

Petaloma also is only represented by a single species in the region of the Manual,—*E. marginata*. (See plate xii., fig. 11.) The seeds are pitted and covered by a white substance which can be removed very readily. The outer cells in a seed before maturity are provided with thickened cross-bars. The palisade-like layer is well developed, and provided with large pores as in many of the species. These cells are twisted; they are largest at the base.

E. corollata, of *Tithymalopsis*, approaches *E. polygonifolia*, *E. Geyeri*, and others of that section. The seeds are shown on plate xii., figure 12. The smooth seeds are ash-colored. The white portion readily separates from the remainder of the seed, so that frequently many of the seeds are of a brown color. This part is also very brittle. A cross-section of the seed is shown on plate xiii., fig. 12. The outer layer is mucilaginous, and the cell-walls are greatly thickened and colorless. The cell-cavity contains a dark substance.

Cross-sections of the seeds were placed in alcohol; stratification could be seen, but on the addition of water these cells began to elongate and the stratification was more pronounced. Iodine produced no change in the walls of the mucilaginous cells, but adding sulphuric acid caused the cell-walls to assume a violet color, which changed to a bluish shade. The granular layer beneath the mucilaginous cells is well developed. Iodine causes the granules in these cells to become blue. Underneath the granular layer is a row of slightly elongated cells; this is followed by the palisade-like cells. The pores in these cells are not so prominent as in the last species. The parts below the palisade layer are usually much compressed. But two rows of cells can be distinguished.

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52. G. Haberlandt: Physiologische Pflanzenanatomie, Leipzig, 1884. Engelm., p. 159.

In *Poinsettia*, *E. dentata* and *E. heterophylla* were studied. The seeds are shown on plate xii., figures 13 & 14. *E. dentata* is less tuberculated. In *E. heterophylla* the ripe seeds may be of pale color or blackish. The pale color is due to the white mucilaginous layer covering them, which, after exposure to water, has exfoliated, showing the dark palisade-like layer underneath, thus giving to the seeds a darker color. A cross-section of *E. heterophylla* is shown on plate xiii., figure 11. The cell-walls are nearly colorless, and the cell-cavity is very much reduced. The pores of the palisade-like cells are well developed. The granular layer contains the usual granules, which show the starch reaction. The layer next to the endosperm is very much compressed, and the cells are elongated and thin-walled.

The general character of the seeds of *E. dentata* is much like that of the last species. (See plate xii., figure 13.) A cross-section of the seed is shown on plate xiii.; at figure A, a general outline of the ridges and the depressions. These points are caused by the cells, which project like little papillæ; the number of cells is somewhat variable. The cell-walls are colorless, and the cell-cavity is filled with a brown substance as in the last species. The palisade-like cells are well developed; the pores are conspicuous and come out clearly. Next to the endosperm is a layer of cells provided with thickened ridges, such as occur in *E. marginata* and *E. hexagona.*

The following species of *Tithymalus* were studied: *E. obtusata*, *E. Cyparissias*, *E. commutata*, and *E. Lathyris.*

The seeds of *E. obtusata* are blackish and smooth. A cross-section shows that the outer cells appear somewhat like papillæ in places. The cell-walls are colorless (Pl. xiii., figure 5A) and are provided with pores (5B*a*). Between the palisade cells and this layer several rows of thin-walled elongated cells occur: these, on account of compression, are indistinct. The palisade cells are of the usual kind: they are followed by thin-walled elongated cells, also very much compressed.

The smooth and dark colored seeds of *E. Cyparissias* are shown on plate xii., fig. 18*c;* cross-section of the seed, on plate xiii., fig. 16. The seed shows the usual palisade-like cells, and the overlying and u derlying parenchyma cells.

E. commutata: the seeds are beautifully sculptured, and ash-colored (see plate xii., fig. 19). A cross-section of the seed is shown on plate xiii., fig. 6. The outer layer is made up of mucilaginous cells, with greatly thickened colorless walls. Underlying this layer is the granular portion, the cells of which come out much clearer than in most of the species. Iodine colors the granules blue. Iodine causes no change in the cell-walls of the mucilaginous layer, but with sulphuric acid it colors them blue. The palisade-like cells are of the usual kind, as are also the cells which follow them.

E. Lathyris (see plate xii., fig. 19*a*). This species has been studied by Harz.[53] My studies do not quite agree with his. The outer cells are thicker walled (see figure 9, Pl. xiii.); the pores of the palisade-cells are more numerous than shown in his sketch. It appears from his investigation that these cells contain large quantities of lime and silica.

Conclusions.—From a systematic point of view the seed-coats offer few characters which are of sufficient importance to use in distinguishing species; closely related species show a similar structure in the seed-coats. Where the outer surface of the seed shows sculpturing or marking, the minute structure shows corresponding differences, as in *E. hexagona* and *E. marginata*. The ashy part, which covers many seeds, is changed into mucilage on the addition of water, and in the case of *E. polygonifolia* spirals are developed. Michrochemically this substance appears to be similar to the mucilage of *Linum*, *Ruellia*, *Ocimum*, *Salvia*, &c. The mucilaginous part is very brittle when dry, and hence in many seeds this has broken away. Underlying the mucilaginous layer is a narrow zone in which starch-grains are abundant. This layer occurs only, so far as I have been able to make out, in connection with the mucilaginous layer. It is most highly developed where the mucilaginous layer is best developed. Thus it appears as though it were intimately connected with the formation of this portion of the seed.

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53. L. c., p. 831.

PARTIAL BIBLIOGRAPHY OF MUCILAGINOUS SEED-COATS AND PERICARPS.

The author of the paper given, is followed either by the title of the paper or by number in parenthesis referred to in the body of this contribution.

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Berteroa incana—Abraham (21), p. 10. Plate xxv. Figs. 1-22. Caspary: Genera Plantarum Flor. Germ. xvii. Bonn, 1853.

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B. dichotoma—Kiaerskou: Om Frökallens Byggning hos nogle "Indiske Raps-sorter." Botanisk Tidsskrift, vol. xiv. 1885, p. 249. Sur la structure du teste de quelques de "Colza indien." Bot. Tidssk. vol. xiv. p. 17–21, 1 Pl. Abst. C. Müller Just, Bot. Jahresb. 1885, p. 826.

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B. juncea—Wiesner (20), p. 732. Hanausek (20), p. 334. Moeller (20), p. 262. Schimper (20), p. 133. Hager: Das Mikroskop, &c. p. 147.

B. Napus—Wiesner (20), p. 735. Hanausek (20), p. 348. Moeller (20), Figs, 201, 202. Nobbe (25*b*), p. 86, Fig. 85. Höhnel (25*a*), p. 183, Figs. 13–17. Harz (2), p. 932, Fig. 74. Sempolowski (24), p. 43. Plate iii. Figs. 20-26. Beitraege, &c. p. 855, Figs. 20–26.

B. nigra—Wiesner (20), p. 732. Hanausek (20), p. 334, Fig. 85. Moeller (20), p. 260, Fig. 225; Schimper (20), p. 96, 133; Fig. 61. Henkel: Handbuch, &c., p. 390. Héraud: Nouvelle Dictionnaire, p. 340. Flückiger & Hanbury (13), p. 64. Höhnel (25*a*), p. 171, Figs. 21–26. Flückiger and Tschirch (26), p. 169. Vogl: Nahrungs—und Genussmittel, p. 116; Fig. 97. Nobbe (25*b*), p. 80, Fig. 88. Berg (25*c*), p.

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B. ramosa—Kiaerskou: Om Frökallens &c.

B. Rapa—Wiesner (20), p. 735. Hanausek (20), p. 343. Moeller (20), p. 238. Schimper (20), p. 94, 98, 110, Figs. 56, 73. Harz (2), p. 937, Fig. 75. Höhnel (25*a*), p. 183, &c., Figs. 18–20. Tietschert. Keimungsversuche mit Roggen und Raps bei verschieden tiefer Unterbringung, Halle, 1872, p. 75, Fig. 40. Hager: Das Mikroskop, &c., p. 147, Fig. 188.

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Camelina sativa—Abraham (21), p. 29, Plate xxvi. Figs. 82-96. Caspary: Genera Plant. Germ. Hofmeister (20), p. 26, Figs. 8, 9. Sempolowski (24), p. 856, Plate viii. Figs. 22, 23. Beitraege, &c. p. 45, Plate iii. Figs. 22, 23. Harz (2), p. 923, Fig. 71.

Capsella Bursa-pastoris—Abraham (21), p. 38, Plate xxvi. Figs. 110–21.

Cochlearia officinalis—Harz (2), p. 918, Fig. 68.

Erophyla vulgaris—Caspary: Genera Plant. Germ. &c.

Erysimum cheiranthoides—Abraham (21), p. 16, Plate xxv. Figs. 23–39.

Iberis amara—Caspary: Genera Plant. Germ. &c.

Isatis tinctoria—Caspary: Genera Plant. Germ. Harz (2), p. 920, Fig. 69.

Lepidium—Kratzmann: Die Lehre von Samen der Pflanzen, &c. p. 41.

L. Humboldtii—Abraham (21), p. 24.

L. ruderale— " (21), p. 19. Plate xxv. Figs. 40–57.

L. sativum— " (21), p. 20, Plate xxv., Figs. 52–61; Plate xxvi. Figs. 61–64. Caspary, Genera Plant. Germ. Hofmeister (20), p. 20. Sempolowski (24), p. 857, Plate viii. Figs. 24A & 24B. Beitrae-

CRUCIFERÆ (continued).

ge, &c. p. 46. Plate iii. Figs. 24A and B. Schenck: Botanische Notizen Würzburger Naturwissenschaftliche Zeitung, vol. ii., p. 217. Harz (2), p. 922, Fig. 70. Uloth (19), Figs. 8–11.

L. Virginicum—Abraham (21), p. 24.

Lobularia maritima—Caspary: Genera Plant. Germ. &c.

Lunularia biennis—Caspary: Genera Plant. Germ. &c.

Myagrum perfoliatum—Caspary: Genera, Plant. Germ. &c.

Raphistrum rugosum—Caspary: Genera Plant. Germ. &c.

Raphanus—Caspary: Genera Plant. Germ. &c.

R. Chinensis—Sempolowski (24), p. 858, Plate viii. Fig. 26; Beitraege, &c. p. 48, Plate iii. Fig. 26.

R. Raphanistrum—Harz (2), p. 946.

R. sativus—Harz (2), p. 944, Fig. 78.

Sisymbrium Sophia, L.—Abraham (21), p. 35, Plate xxvi. Figs. 97–109.

S. Irio—Hofmeister (20), p. 19. Abraham (21), p. 9.

Teesdalia nudicaulis—Abraham (21), p. 9. Hofmeister (20), Plate xvi. Figs. 13–17. Frank (22), p. 172, Plate xvi. Figs. 13–17. Strandmark: Bitrag till Kännedomen &c. Hofmeister (20), p. 23, Figs. 4–7. Behrens (26), p. 329.

Thlaspi arvense—Caspary: Genera Plant. Germ.

CISTACEÆ.

Fumana lævipes—Schenk (33).

Helianthemum—Schenk (33).

LINACEÆ.

Linum æthiopicum—Harz (2), p. 957.

L. angustifolium—Harz (2), p. 957.

L. catharticum—Harz (2), p, 957.

L. juniperifolium—Harz (2), p. 957.

L. usitatissimum—Flückiger and Hanbury (13), p. 97. Uloth (19), p. 193. Sempolowski (24), p. 825, Plate vii. Figs. 1–3; Beitraege, &c., p. 3, Plate i. Figs. 1–3. Cramer (16), p. 1, Plate xxvii.; Figs. 6–18. Plate xxvii. Kühn: Die zweckmäszigste Ernährung des Rindviehs. Dresden, 1871, 5th edition. Dr. Otto Berg: Pharmaceutische Waarenkunde. 4 Auflage Garcke. Berlin, 1869. Harz (2), p. 950, Fig. 952. Kützing (7), vol. i., p. 194. Frank (22), p. 161, &c.; Plate xv. figs. 1–4. Henkel: Handbuch, &c., p 374. Stillé & Maisch: National Dispensatory, Philadelphia, 1879, p. 816. Fig. 99. Luerssen (20), vol. ii. p. 674. H. Karsten: Deutsche Flora, Pharmaceutische medicinische Botanik, Berlin, 1880–83, p. 605, Fig. 360. J. Forbes Royle and Fred. W. Headland, Man. of Mat. Med. &c., p. 331. Nobbe (25*b*), p. 80, Fig. 81. Sachs: Experimentalphy-

LINACEÆ (continued).

siologie der Pflanzen. p. 368. Schimper (20), p. 79,94, 98, 110, Figs. 52. 58. 74. Carl Ritter von Schroff: Lehrbuch der Pharmakognosie. Vienna. 1864, 2 Aufl. Moeller (20), p. 173. Wiesner (20), p. 723. Behrens (26), p. 329, 374. Kratzmann: Die Lehre von Samen, &c., p. 41. Flückiger & Tschirch (26), p. 166. Pereira: "Elements of Vegetable Materia Medica and Therapeutics," edited by Robert Bentley and Theophilus Redwood," London, 1872, p. 924. Vogl: Nahrungs-und Genussmittel. &c., p. 131, Fig. 105. Jonathan Pereira: "The Elements of Materia Medica and Therapeutics," 4th edition, 2 vols. 1855, p. 561. He also refers to Bostock Nicholonson's Jour., vol. xviii. p. 31; Vanquelin, Ann. de Chem., vol. lxxx. p. 3114; Guérin-Vary, Jour. Chem. Med., vol. vii. p. 739, for the chemistry of these mucilages.—Hager: Das Mikroskop, &c., p. 150, Fig. 189. Goodale (42), p. 36.

ROSACEÆ.

Pyrus malus—Kratzmann: Die Lehre von Samen, &c., p. 41.

P. (Cydonia) vulgaris—Cramer (16), p. 1, Plate xxvii. Figs. 3–5. Frank (22), p. 167, &c., Plate xv. Figs. 8 & 9. Hanausek (20), p. 205. W. O. Focke in Engler and Prantl: Die natürlichen Pflanzenfamilien Rosaceæ, iii. Theil. 3 Abth., p. 22. Royle and Headland: Manual of Thérapeutics, &c. p. 434. Uloth (19), p. 193. Pereira: Elements of Materia Medica, &c., p. 303. Pereira: Elements of Materia Medica, Robert Bentley, London. 1872. p. 826. A. J. DeLeus: Dictionaire Universel de Matière Médicale et des Thérapeutiques générales, Paris. 1830, vol. ii. p. 558. Kratzmann: Die Lehre von Samen, &c. p. 41. Henkel: Handb. Pharm. &c. p. 365. Hermann Hager: Botanischer Unterricht in 160 Sectionen für angehende Pharmaceuten und studirende Mediciner. 3d edition, Berlin, 1885. p. 450, Fig. 657. Stillé and Maisch: Nat. Dispensatory. p. 487. Fig. 54. Karsten: Deutsch Flor. &c. p. 783, Fig. 449. R. F. Scoresby Jackson: "Note Book of Materia Medica, Pharmacology and Therapeutics;" 2d edition, Dr. R. Angus McDonald, Edinburgh, 1871, p. 437. Hèraud: Nouvelle Dict. &c., p. 150. Hofmeister (20), p. 22. 30, &c., Plate i. Fig. 3. Klenke (20), p. 518. Flückiger & Hanbury (13), p. 269. Luerssen (20), vol. ii. p. 834. Flückiger & Tschirch (26), p. 166.

SAXIFRAGACEÆ.

Ribes—Gray: Manual of Botany, revised edition. Watson & Coulter, p. 174.

COMPOSITÆ.

Amellus—Schenk (33). Harz (2), p. 842.

Aster—Schenk (33). Harz (2), p. 842.

Aplopappus—Schenk (33). Harz (2), p. 842.

COMPOSITÆ (continued).

Callistephus—Schenk (33). Harz (2), p. 842.
Carlinia—Schenk (33). Harz (2). p. 842.
Chareicis—Schenk (33). Harz (2), p. 842.
Conyza—Schenk (33). Harz (2). p. 842.
Cremocephalum cernuum—Schenk (33).
Erigeron Canadense—Nobbe (25*b*). p. 83. Fig. 92. Harz (2). p. 842.
Erechitis—Schenk (33). Harz (2). p. 842.
Eurybiopsis—Schenk (33). Harz (2). p. 842).
Felicia—Schenk (33). Harz (2). p. 842).
Helenium—Schenk (33). Harz (2). p. 842.
Heteropappus—Schenk (33). Harz (2). p. 842.
Inula—Schenk (33). Harz (2). p. 842.
Senecio—Goodale (42). p. 36. Gray: Syn. Flora. vol. i. pt. ii. p. 383; most species with minute short hairs, which swell and emit a pair of spiral threads when wetted.
— *vernalis*—Nobbe (25*b*), p. 82. Figs. 90. 91. Harz (2), p. 842.
Stenactis—Schenk (33). Harz (2). p. 842.
Zeranthemum—Schenk (33). Harz (2). p. 842.

POLEMONIACEÆ.

Collomia—Nägeli (32). p. 119. Abraham (21). p. 8. Caspary. Bot. Zeit., 1852. p 663; 1854. p. 390. Goodale (42). p. 36.
C. coccinea—Nägeli (32). p. 119. Plate i. Fig. 167. Hofmeister (20), p. 28. Plate i. Fig. 13. Gray (30*a*). p. 259.
C. grandiflora—Gray (30*a*). p. 259.
C. gilioides—Gray (30*a*). p. 269.
C. heterophylla—Nägeli (32). p. 119. Hofmeister (20), p. 28. Plate i. Figs. 12. 14. Gray (30*a*), p. 260. Lindley (29).
C. linearis—Nägeli (32). p. 119. Balfour (36). p. 19. Gray (30*a*), p. 259. Lindley (28).
C. nudicaulis—Gray (30*a*). p. 258.
C. tenella—Gray (30*a*). p. 259.

All species of section *Eucollomia*, with the exception of *Collomia gracilis*, are provided with mucilaginous spirals.—Gray: Syn. Flora. vol. ii. Pt. i. p. 134.

Gilia (Leptosiphon)—Schleiden: Beiträge Phytogenesis Miller's Archiv. Phys. vol. ii. Plate iv.

G. aurea—	Gray	(30*a*).	p. 263.
G. Bigelovii—	"	"	p. 265.
G. Bolanderii—	"	"	p. 263.
G. demissa—	"	"	p. 263.
G. dianthoides—	"	"	p. 264.
G. dichotoma—	"	"	p. 265.

POLEMONIACEÆ (continued).

G. liniflora— Gray (30*a*). p. 263.
var. *phornaccoides*— " " p. 263.
G. pusilla— " " p. 263.

The seed-coats of many of the species of Series I. of *Gilia*, including the sections *Dactylophyllum*. *Linanthus*, *Leptosiphon*, *Siphonella*, and *Leptodactylon*, are mucilaginous.—Gray Synop. Flora, vol. ii. Pt. i. p. 137.

Polemonium—"Seed-coat developing mucilage and spiracles when wetted."—Gray: Syn. Flora. vol. ii. Pt. i. p. 150.

P. cæruleum— Gray (30*a*). p. 281.
var. *foliosissimum*— " " p. 281.
P. confertum— " " p. 280.
var. *mellitum*— " " p. 280.
P. humile— " " p. 281.
P. Mexicanum— " " p. 281.
P. micranthum— " " p. 282.
P. reptans— " " p. 281.
P. viscosum— " " p. 280.

ACANTHACEÆ.

Gray: Syn. Flora. vol. ii. Pt. i. p, 321. Goodale (42), p. 36.

Ætheilema—Kippist (30). p. 69, Gray: Syn. Flora, vol. ii. Pt. i. p. 321.
A. reniforme—Kippist (30), p. 70.
Acanthodium—Hofmeister (20), p. 27.
A. spicatum?—Kippist (30). p. 66, Plate vi. Figs. 1–3.
Blepharis boerhaaviæfolia—Kippist (30). p. 67.
B. molluginifolia—Hofmeister (20). p. 27. Kippist (30), p. 67, Plate vi. Figs. 4, 5.
B. rubiifolia—Kippist (30), p. 67.
Blechum Brownei—Kippist (30), p. 71, Plate vi. Fig. 7.
Dipteracanthus— Kippist (30). p. 70.
D. dejectus— " " p. 70.
D. erectus— " " p. 70.
D. patulus— " " p. 70.
Dyschoriste cernua— " " p. 69.
D. littoralis— " " p. 69.
Hygrophila— " " p. 69.
H. quadrivalis— " " p. 69.
H. obovata— " " p. 69.

ACANTHACEÆ (continued).

H. phlomoides— Kippist (30), p. 69.

H. salicifolia— " " p. 69.

Ruellia—Mohl: Bot. Zeit., 1844, p. 323. Frank (22), p. 172. Gray: Synopt. Flora, vol. ii. Pt. i. p. 325. Goodale (42), p. 36.

R. ciliata—Frank (22), p. 172. Hofmeister (20), p. 27. Nägeli (32), p. 120, Plate i. Figs. 3-7.

R. formosa—Kippist (30), p. 68, Plate vi. Fig. 6.

R. patula—Hofmeister (20), p. 27.

R. strepens—Hofmeister (20), p. 27. Mohl, Bot. Zeit., 1844, p. 323. Kippist (30), p. 68.

R. tuberosa—Hofmeister (20), p. 27.

Stenosiphonium subsericeum—Kippist (30), p. 70.

Strobilanthes— " " p. 69.

S. Brunoniana— " " p. 70.

S. fimbriata— " " p. 70.

S. imbricata— " " p. 70.

S. monadelpha— " " p. 70.

S. scabra— " " p. 69.

S. Wallichii— " " p. 70.

LABIATÆ.

Harz (2), p. 867. Luerssen (20). vol. ii. p. 1014. Goodale (42), p. 36.

Calamintha—Schenk (33). Harz (2), p. 867.

C. alpina—Harz (2), p. 867. Schenk (33).

Dracocephalum Moldavica—Nägeli (32), p. 115

D. nutans—Schleiden (31). Harz (2), p. 867.

D. thymiflorum— " " " " p. 867.

Elshotzia—Schenk (33). " " p. 867.

Lallemantia iberica— " " p. 868. Schleiden (31).

L. peltata—Junowicz: Die Lichtlinie in den Prismenzellen der Samenschalen. Sitzungsber. d. K. Akad. d. Wiss. zu. Wien. lxxvi. Abth. i. Oct. 1877.

Lavandula Stoechas—Schenk (33). Harz (2), p. 867.

Majorana— " " " " p. 867.

Melissa— " " " " p. 867.

Mentha— " " " " p. 867.

Nepeta— " " " " p. 867.

Ocimum basilicum—Nägeli. (32). p. 114. &c.; Plate i. Figs. 12 & 13. Schleiden (31).

LABIATÆ (continued).

Origanum—Schenk (33). Harz (2), p. 867.

Preslia— " " " " p. 867.

Plectanthrus parviflorus—Schenk (33). Harz (2), p. 867.

Prunella grandiflora—Nobbe (25*b*), p. 82. " " p. 867.

P. vulgaris— " " p. 82, Fig. 89. Harz (2), p. 867.

Salvia—Frank (22), p. 169, &c. Nägeli (32), p. 116. Schleiden 311. Goodale (42), p. 36.

S. Æthiopis— " " p. 116. Plate i. Fig. 11.

S. carduacea— Gray (36). Synopt. Flora, vol. ii. Pt. i. p. 366.

S. columbariæ— " " " " " " p. 367.

S. Hormium—Nägeli (32), p. 117. Plate i. Fig. 1. Frank (22), p. 169. Hofmeister (20), p. 27. Schleiden (31). Plate vii. Fig. 97. Behrens (26), p. 329.

S. sylvestris—Frank (22), p. 170, Plate xv. Figs. 10. 11; Plate xvi. Fig. 12.

S. verbenaceæ—Balfour (36*b*), p. 19.

Satureja—Schenk (33). Harz (2), p. 867.

Ziziphora dasyantha—Schleiden (31), Plate iv.

Z. capitata—Schenk (33).

PLANTAGINACEÆ.

Plantago—Gray, Synopt. Flora, vol. ii. Pt. i. p. 389. Frank (22), p. 162, &c. Harz (2), p. 982. Tollens: Jour. f. Landwirtschaft, 1874, p. 502. Luerssen (20), vol. ii. p. 1038.

P. arenaria—Henkel: Handbuch, &c. p. 366. Wiesner (20), p. 744. Harz (2), p. 984.

P. cynops—Henkel: Handbuch, &c. p. 366. Harz (2), p. 985.

P. lanceolata—Frank (22), p. 164. Harz (2), p. 986, Fig. 89.

P. major—Harz (2), p. 982.

P. maritima—Harz (2), p. 986. Uloth (19), p. 193. Pl. vi. Figs. 1–7.

P. media—Harz (2), p. 984. Henneberg: Jour. f. Landw., 1859, p. 246.

P. Psyllium—Cramer (16), p. 1. Pl. xxvii. Figs. 1, 2. Wiesner (20), p. 743. Fig. 30. Frank (22), p. 164, &c. Harz (2), p. 986. Flückiger & Tschirch, p. 169. Behrens (26), p. 374. Uloth (19), p. 193.

CASAURINEÆ.

Casaurina—Brown (27).

HYDROCHARIDACEÆ.

Hydrocharis—Schleiden (31).

ORCHIDACEÆ.

Renanthera coccinea—Robert Brown (27).

EXPLANATION OF PLATE XII.

All seeds drawn to the same scale magnified 12 times.

The figures are numbered to correspond to the species in Gray's Manual, Revised Edition, pp. 452-456.

1.	*Euphorbia*	*polygonifolia*, L.	
2.	"	*Geyeri*, Engelm.	
3.	"	*petaloidea*, Engelm.	
4.	"	*serpens*, HBK.	
5.	*Euphorbia*	*serpyllifolia*, Pers.	*Anisophyllum.*
6.	"	*glyptosperma*, Engelm.	
7.	"	*maculata*, L.	
8.	"	*humistrata*, Engelm.	
9.	"	*Preslii*, Guss.	
10.	*Euphorbia*	*hexagona*, Nutt.	*Zygophyllidium.*
11.	*Euphorbia*	*marginata*, Pursh	*Petaloma.*
12.	*Euphorbia*	*corollata*, L.	*Tithymalopsis.*
13.	*Euphorbia*	*dentata*, Michx.	*Poinsettia.*
14.	"	*heterophylla*, L.	
15.	*Euphorbia*	*Ipecacuanhæ*, L.	
16.	"	*Darlingtonia*, Gray	
17.	"	*obtusata*, Pursh	
17*a*.	"	*platyphylla*, L.	
18.	"	*dictyosperma*, Fischer & Meyer	
18*a*.	"	*Helioscopia*, L.	*Tithymalus.*
18*b*.	"	*Esula*, L.	
18*c*.	"	*Cyparissias*, L.	
18*d*.	"	*Nicæensis*, All.	
18*e*.	"	*Peplus*, L.	
19.	"	*commutata*, Engelm.	
19*a*.	"	*Lathyris*, L.	

EXPLANATION OF PLATES XIII. AND XIV.

Fig. 1. *a*. Mucilaginous spirals of *E. polygonifolia*: *b*. surface view of mucilaginous cells.

Fig 2. Cross-section; seed of *E. polygonifolia*. *a*. Mucilaginous cells showing stratification; *b*. the underlying granular portion; *p*. palisade-like cells; *c*. elongated parenchyma cells; *e*. endosperm.

Fig. 3. Cross-section, seed of *E. marginata*. *a*. Outer cells showing elongated thickenings; *a'b*. underlying parenchymatous layers; *p*. palisade-like cells; *c' d*. two layers following the palisade-like cells, belonging to the inner seed-coat.

Fig. 4. Cross-section, seed of *E. dentata*. *B*. Showing the general arrangement of the papillate-like outer cells; *A a*. mucilaginous papillate-like cells; *b*. underlying granular portion; *p*. palisade-like cells; *c*. parenchyma cells belonging to inner seed-coat; *c'*. layer next to the endosperm; *e*. cells provided with cross-thickenings.

Fig. 5. Cross-section; seed of *E. obtusata*. *A a*. Outer layer of papillate-like cells; *a'*. underlying thin-walled elongated cells; *p*. palisade-like cells; *e*. thin-walled elongated cells; *Ba*. some of the outer cells showing pores.

Fig. 6. *A*. Cross-section; seed and caruncle of *E. commutata*. *a*. Outer mucilaginous cells; *d*. underlying granular portion; *p*. palisade-like cells; *e*. endosperm. *B*. Cross-section of caruncle.

Fig. 7. Cross-section; seed of *E. Geyeri*. *a*. Mucilaginous cells; *b*. underlying granular portion; *b'*. parenchymatous layer next to the palisade-like cells *p*; *c*. thin-walled parenchyma cells next to the endosperm.

Fig. 8. *a'*. Surface view of a few vessels in the seed-coats of *E. Geyeri*. *b'*. Mucilaginous cells of the same species in surface view.

Fig. 9. Cross-section; seed of *E. Lathyris*. *a*. Thick-walled outer cells. The outer portion of cell-wall colorless, while the inner is of dark brown color; *a'-b'*. thick-walled cells next to palisade-like cells *p*. According to Harz, the cells of *b'* are said to be mucilaginous.

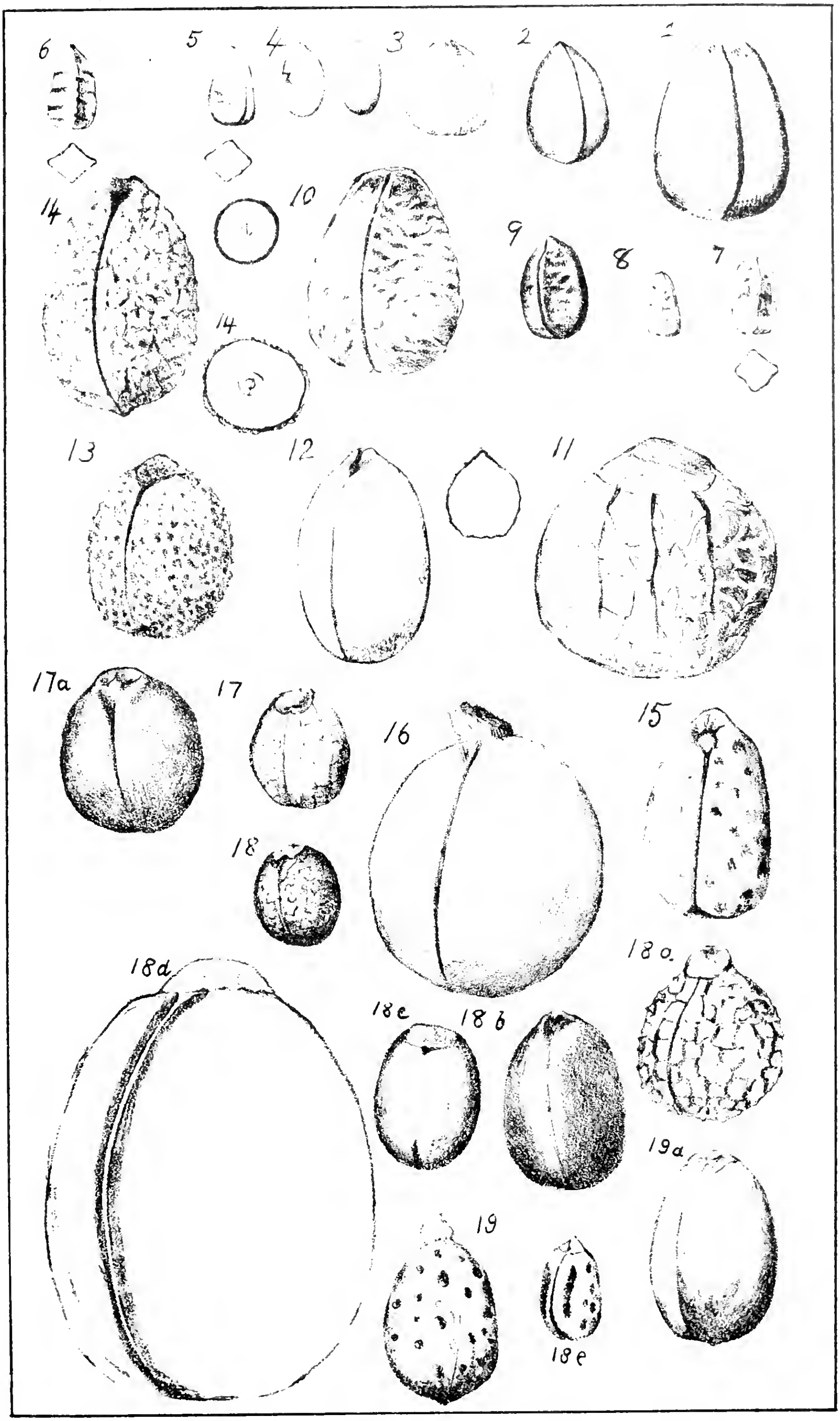
Fig. 10. Cross-section; seed of *E. hexagona*. *Aa*. Outer mucilaginous cells; *b*. underlying granular portion; *p*. palisade-like cells; *c*. elongated thin-walled cells; *c'*. cells provided with thickenings running across the cells; *E*. endosperm; *B*. mucilaginous cells; *a*. underlying granular portion; *b*, *a'*. an expanded mucilaginous cell; *C*. showing general arrangement of mucilaginous cells at *a*.

Fig. 11. Cross-section; seed of *E. heterophylla*. *a*. Outer mucilaginous cells. Cell contents brown; *b*. underlying granular portion, followed by a layer of thin-walled cells, *b'*, and sclerotic cells, *c'*: *p*. palisade-like cells; *c*. elongated thin-walled cells belonging to inner seed-coat.; *E*. endosperm.

Fig. 12. Cross-section; seed of *E. corollata*. *Aa*. Mucilaginous cells with dark brown contents showing stratification of the cell-walls; *b*. underlying granular portion; *b'*. thin-walled parenchyma cells; *p*. palisade-like cells; *a'c*. thin-walled parenchyma cells next to the endosperm; *B*. *a*. mucilaginous cells showing stratification; *b*. underlying granular portion.

Fig. 13. Cross-section; seed of *E. glyptosperma*. *a*. Mucilaginous cells; *b*. underlying granular portion; *p*. palisade-like cells; *r*. thin-walled elongated cells; *E*. endosperm.

Fig. 14. Cross-section; seed of *E. Cyparissias*. *a*. Outer layer of cells; *a'*. thin-walled parenchyma layer of cells; *p*. palisade-like cells; *c*. thin-walled parenchyma cells next to endosperm.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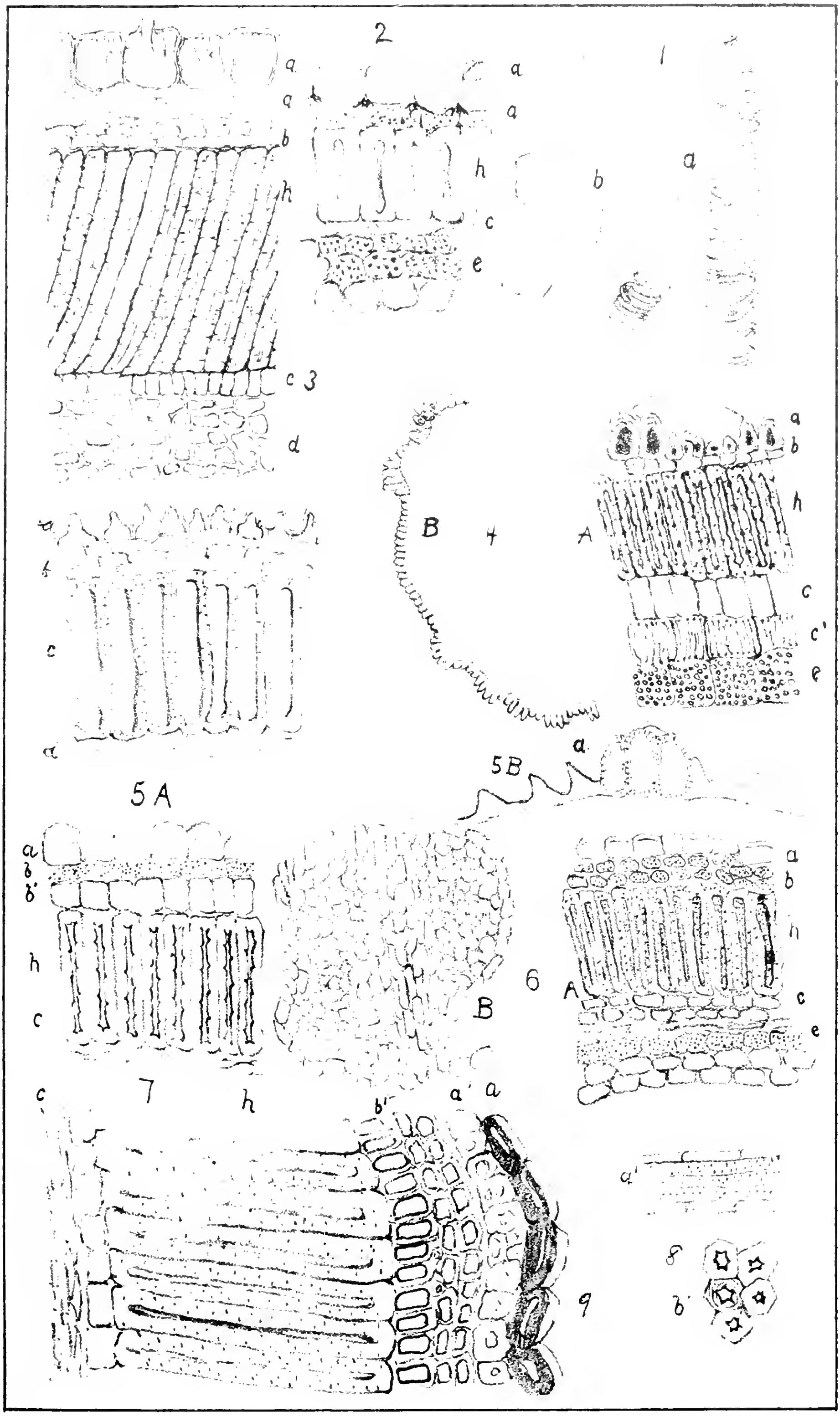
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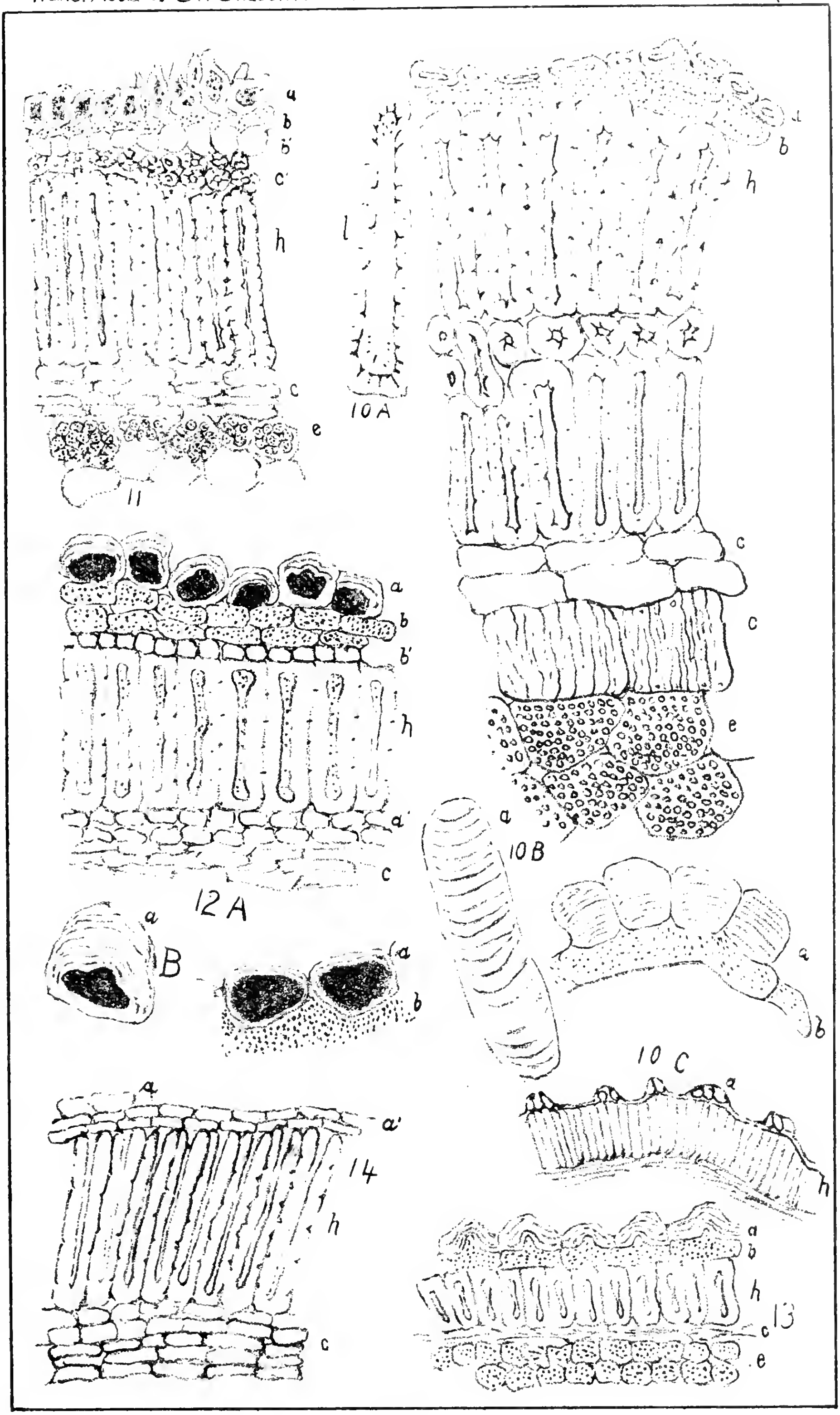
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Flowers and Insects, Asclepiadaceæ to Scrophulariaceæ.

By Charles Robertson.

Presented Feb 2d, 1891.

The following paper belongs with a series of papers begun in the Botanical Gazette in May, 1889, and giving an account of observations made at Carlinville, Ill., in 1866 and following years. The paper on "Umbelliferæ," in the fifth volume of these Transactions, pp. 449–460, belongs with the same series.

A bibliography of the literature of the fertilization of flowers by D'Arcy W. Thompson will be found in Hermann Müller's "Fertilization of Flowers," 599–634. This list includes works published up to 1883. A continuation of this bibliography up to 1889, by J. McLeod, will be found in the Botanisch Jaarboek, Gent, Tweede Jaargang, 1890

ASCLEPIADACEÆ.

In the Botanical Gazette, vol. xii., 207–216, 244–250, I have given an account of the following species of *Asclepiadaceæ.* I shall now add a list of visitors of each of them. The name of each insect is followed by c., h., t., p., or sp., according as the corpuscula were found attached to the claws, hairs of the legs, tongue, pulvilli, or spurs of the tibiæ. In most cases, however, the pulvilli and spurs are counted as hairs and marked "h."

Asclepias verticillata, L.—On 15 days, between July 11 and Aug. 21, I observed the following visitors:

Hymenoptera —*Apidæ.* (1) Apis mellifica L. ☿, h.; (2) Bombus separatus Cr. ♂ ♀ ☿, h.; (3) B. virginicus Oliv. ☿ h.: (4) B. americanorum F. ☿; (5) Apathus laboriosus F. ♀, h.; (6) Melissodes bimaculata Lep. ♂ ♀ h.t.; (7) Ceratina dupla Say ♀, h.c.p.; (8) Megachile brevis Say ♂ ♀, h.t.; (9) Heriades carinatum Cr.. ♀ p.; (10) Cœlioxys 8-dentata Say ♂, h.; (11) Epeolus lunatus Say ♂. h. *Andrenidæ.* (12) Halictus lerouxii Lep. ♂ ♀, h.c.t.; (13) H. fasciatus Nyl. ♂ ♀. h. (14) H. confusus Sm. ♀, p.; (15) H. stultus Cr. ♀; (16) H. albipennis Rob. ♂;

(17) Agapostemon radiatus Say ♀: (18) Sphecodes mandibularis Cr. ♂; (19) Prosopis affinis Sm. ♀. p. *Vespidæ.* (20) Polistes pallipes Lep. h. *Eumenidæ.* (21) Eumenes fraternus Say. h.c.t.; (22) Odynerus arvensis Sauss. h.; (23) O. foraminatus Sauss. h.; (24) O. anormis Say, h.t. *Crabronidæ.* (25 Crabro interruptus Lep.; (26) C. rufifemur Pack., h. p.; (27) Oxybelus frontalis Rob. *Philanthidæ.* (28) Cerceris sp., h.; (29) C. clypeata Dahlb., h.c.; (30) C. bicornuta Guér., h.; (31) C. compacta Cr., h.c.; (32) C. finitima Cr. *Bembecidæ.* (33) Bembex nubillipennis Cr., h. *Larridæ.* (34) Astata unicolor Say, h.; (35) Tachytes distinctus Sm., h.; (36) T. validus Cr., h.; (37) T. pepticus Say, h. *Sphecidæ,* (38) Ammophila intercepta Lep.; (39) Pelopœus cementarius Dru.; (40) Isodontia philadelphica Lep., h.; (41) Sphex ichneumonea L., h.; (42) S. pennsylvanica L., h.; (43) Priononyx thomæ F., h.; (44) P. atrata Lep. *Pompilidæ,* (45) Pompilus sp., h.; (46) Priocnemis terminatus Say, h.; (47) P. fulvicornis Cr., h. *Scoliidæ.* (48) Myzine sexcincta F., h.t.; (49) Scolia bicincta F., h. *Formicidæ.* (50) Phrenolepis sp. *Chrysididæ,* (51) Holopyga ventralis Say. *Tenthredinidæ,* (52) Hylotoma humeralis Beauv., h.

Diptera.—*Midasidæ,* (53) Midas clavatus Dru., h. *Bombylidæ,* (54) Systœchus vulgaris Lw. *Empidæ,* (55) Empis sp. *Conopidæ,* (56) Physocephala tibialis Say, h.; (57) Conops xanthopareus Will., h.; (58) C. brachyrrhynchus Macq. *Syrphidæ,* (59) Paragus bicolor F.; (60) Chrysogaster nitida Wied.; (61) Allograpta obliqua Say; (62) Mesograpta polita Say; (63) M. marginata Say; (64) Sphærophoria cylindrica Say; (65) Eristalis latifrons Lw., h.; (66) E. transversus, Wied.; (67) Tropidia quadrata Say. h.; (68) Syritta pipiens L., c. *Tachinidæ.* (69–72) spp., t.; (73) Hyalomyia purpurascens Towns.;* (74) Trichopoda pennipes F.; (75) Cistogaster divisa Lw.; (76) Ocyptera euchenor Walk., t.; (77) Wahlbergia arcuata Say. t.; (78) Jurinia apicifera Walk., h.; (79) Micropalpus sp., h.t.; (80) Exorista theclarum Scud.; (81) Mascicera sp.; (82) Eggeria? sp.; (83) Acroglossa hesperidarum Will., h.c.p.t. *Sarcophagidæ.* (84–87) Sarcophaga spp. *Muscidæ,* (88) sp.; (89) Lucilia sp.; (90) L. cæsar L., c.; (91) L. cornicina F., h.c.p.t.; (92) L. macellaria F., c.t. *Anthomyidæ,* (93) Anthomyia sp.; (94–5) Limnophora sp. *Sepsidæ,* (96) Sepsis sp.

Lepidoptera.— *Rhopalocera.* (97) Papilio cresphontes Cram.; (98) Pieris rapæ L., h.; (99) Colias philodice Godt.; (100) Danais archippus F., h.; (101) Argynnis cybele F.; (102) Phyciodes tharos Dru.; (103) Pyrameis atalanta L.; (104) Chrysophanus thoe Bd.-Lec.; (105) Lycæna comyntas Godt.; (106) Pamphila peckius Kby., h.; (107) P. cernes Bd.-Lec.; (108) P. verna Edw.; (109) Pholisora catullus F.; (110) P. hayhurstii Edw., h.; (111) Eudamus lycidas Sm.-Abb. *Pyralidæ,* (112) Scepsis fulvicollis Hübn.

* Kindly named and described for me by Mr. C. H. Tyler Townsend, Nos. 76 and 77, determined by him.

Coleoptera.—*Scarabæidæ*, (113) Trichius piger F. *Cerambycidæ*, (114) Typocerus sinuatus Newm. *Rhipiphoridæ*, (115) Rhipiphorus limbatus F.

Of the 58 species bearing pollinia of this *Asclepias*, 52 have the corpuscula attached to the hairs of their legs or to the pulvilli, 10 have them on their claws, and 13 have them on their tongues.

Asclepias incarnata L.—The following visitors were taken on 24 days, between July 22 and Aug. 21:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, h.t., ab., one dead; (2) Bombus virginicus Oliv. ♀ ☿. h.c.t.; (3) B. vagans Sm. ♄. h.c.t; (4) B. americanorum F. ♄ ♀ ☿, h.c.t.; (5) B. pennsylvanicus DeG. ♄ ♀ ☿, h.c.; (6) B. scutellaris Cr. ♄ ☿, h.c.t.; (7) B. separatus Cr. ♄ ♀ ☿, h.c., very ab.; (8) Entechnia taurea Say ♄, h.; (9) Megachile brevis Say ♄ ♀. *Andrenidæ*, (10) Colletes latitarsis Rob. ♀. h.c.t., dead; (11) Halictus coriaceus Sm. ♂. h.t.; (12) H. confusus Sm. ♄; (13) Augochlora pura Say ♄, t. *Vespidæ*. (14) Vespa sp., h.c.t.; (15) V. maculata L.; (16) V. germanica F.. h.; (17) V. cuneata F., h.c.t.; (18) Polistes pallipes Lep., h.t.; (19) P. metricus Say. h.c.; (20) P. rubiginosus Lep., h.c. *Eumenidæ*, (21) Eumenes fraternus Say; (22) Odynerus arvensis Sauss., h.c.t. *Crabronidæ*, (23) Oxybelus packardii Rob., c. *Philanthidæ*. (24) Cerceris clypeata Dahlb., h.c.; (25) C. compacta Cr., h.c.; (26) C. bicornuta Guér. h.c.t. *Nyssonidæ*, (27) Hoplisus rufoluteus Pack., h. *Bembecidæ*, (28) Megastizus brevipennis Walsh. h.; (29) Bembex fasciata F., h.; (30) B. nubillipennis Cr., h. *Larridæ*, (31) Tachytes sp., h.; (32) T. distinctus Sm., h.; (33) T. validus Cr.. h.t.; (34) T. pepticus Say, h. *Sphecidæ*. (35) Pelopœus cementarius Dru., h., one dead; (36) Sphex ichneumonea L., h.; (37) S. pennsylvanica L., h.c.t.; (38) Priononyx atrata Lep.. h.; (39) P. thomæ F.. h. *Pompilidæ*. (40) Pompilus atrox Dahlb., h.; (41) Priocnemis fulvicornis Cr.; (42) P. unifasciatus Say, h.; (43) Agenia accepta Cr., h. *Scoliidæ*, (44) Myzine sexcincta F., h.c.t.; (45) M. interrupta Say, h.; (46) Scolia bicincta F., h.

Lepidoptera.—*Rhopalocera*, (47) Papilio philenor L., h.; (48) P. asterias F., h.c.; (49) P. troilus L., h.; (50) P. turnus L., h.; (51) P. cresphontes Cram., h.; (52) Pieris rapæ L., h.c.; (53) Colias philodice Godt., h.; (54) Danais archippus F., h.; (55) Argynnis idalia Dru., h.; (56) A. cybele F., h.; (57) Phyciodes tharos Dru.; (58) Pyrameis atalanta L., h.c.; (59) Limenitis disippus Godt., h.; (60) Libythea bachmanni Kirtl., h.; (61) Pamphila peckius Kby.; (62) P. cernes Bd.-Lec., h.; (63) P. verna Edw.; (64) Pholisora catullus F.; (65) Eudamus lycidas Sm.-Abb., h.; (66) E. tityrus F. *Pyralidæ*, (67) Scepsis fulvicollis Hübn.

Diptera. — *Midasidæ*, (68) Midas clavatus Dru., h.t. *Bombylidæ*. (69) Sparnopolius fulvus Wied. *Conopidæ*. (70) Conops xanthopareus Will., p.; (71) Physocephala tibialis Say. *Tachinidæ*. (72) sp.; (73) Cistogaster divisa Lw., t.; (74) Acroglossa hesperidarum Will.

Coleoptera. — *Lampyridæ*. (75) Chauliognathus pennsylvanicus DeG., h.c.t., ab. *Scarabæidæ*. (76) Euphoria sepulchralis F., h.c.t., ab.; (77) Trichius piger F., h.

Hemiptera. — *Lygæidæ*. (78) Lygæus fasciatus Dall., h.; (79) L. turcicus F.

Birds.—*Trochilidæ*, (80) Trochilus colubris L., s.; of course it cannot extract the pollinia.

The flowers are gnawed by two beetles: *Tetraopes tetraophthalmus* Forst. and *Epicauta vittata* F.

Of the 63 species bearing pollinia of *Asclepias incarnata*, 60 have the corpuscula on the hairs of their legs or on the pulvilli, 23 have them on their claws, and 20 have them attached to their tongues. Dead insects of three species (1, 10, 35) were found entrapped and killed by flowers.

Asclepias Cornuti Dec.—Observations on the insect visitors of this plant were made on 24 days, between June 21 and July 22. Among the insects which frequent the flowers there are many which are able to reach the nectar, but which, as a rule, do not extract the pollen at all, or run the risk of becoming hopelessly entangled and of losing their lives in consequence. Although an efficient visitor may sometimes be unable to free itself on account of all of its feet becoming entangled simultaneously, as in the case of the insects mentioned under *A. incarnata*, it is obvious that the flower can hardly be considered as adapted to insects which often lose their lives in this way. In a similar way all insects should be regarded as intruders which do not readily extract the pollinia, either on account of their small size, or their way of resting upon the flowers. From these considerations I place the visitors in separate groups.

The following insects were found dead upon the flowers:

Hymenoptera.—*Apidæ*. (1) Apis mellifica L. ☿, p.c.t.

Diptera.—*Tachinidæ*. (2) Acroglossa hesperidarum Will., p. *Sarcophagidæ*, (3) Sarcophaga sp., p. *Muscidæ*, (4) Lucilia cornicina F.; (5) Stomoxys calcitrans L. *Anthomyidæ*, (6) Anthomyia, sp.

Lepidoptera.—*Bombycidæ*, (7) Callimorpha fulvicosta* Clem., p. *Noctuidæ*, (8) Agrostis upsilon Rott.; (9) Drasteria erechtea* Cram., p.

It is a common thing to find dead hive-bees hanging to the flowers. It is evident, therefore, that, to effect the pollination of *A. Cornuti* with certainty, an insect must be larger or stronger than the hive-bee, or at least more able to free itself from the flowers.

The following visitors either do not extract the pollinia at all, or could hardly be expected to transfer the pollinia to any great extent without danger of losing their lives:

Hymenoptera.—*Apidæ*, (10) Megachile brevis Say ♀; (11) Cœlioxys 8-dentata Say ☿ ♀, c. *Andrenidæ*, (12) Augochlora lucidula Sm. ♀; (13) Halictus fasciatus Nyl. ♀, c. *Philanthidæ*, (14) Cerceris clypeata Dahlb.

Diptera.—*Stratiomyidæ*, (15) Odontomyia cincta Oliv. *Bombylidæ*, (16) Hemipenthes sinuosa Wied. *Conopidæ*, (17) Stylogaster biannulata Say. *Syrphidæ*, (18) Eristalis dimidiatus Wied., p.t.; (19) Tropidia mamillata Lw., p.; (20) T. quadrata Say, h.; (21) Syritta pipiens L., p. *Tachinidæ*, (22) Trichopoda trifasciata Lw., p.t.; (23) Cistogaster divisa Lw.; (24) Jurinia apicifera Walk., p.; (25) Micropalpus sp.; (26) Frontina sp., p. *Anthomyidæ*, (27) Limnophora sp., p.

Lepidoptera.—*Rhopalocera*, (28) Thecla calanus Hübn.; (29) Chrysophanus thoe Bd.-Lec.; (30) Pamphila peckius Kby.; (31) P. cernes Bd.-Lec.; (32) P. dion Edw.; (33) Pholisora catullus F. *Sphingidæ*, (34) Chærocampa tersa L., h. *Pyralidæ*, (35) Scepsis fulvicollis Hübn., h.; (36) Eurycreon rantalis Guen.

Coleoptera.—*Lampyridæ*, (37) Photinus pyralis L., h.

Hemiptera.—*Lygæidæ*, (38) Lygæus fasciatus Dall., h.; (39) L. turcicus F., h.c. *Pentatomidæ*, (40) Euschistus variolaris P.B., h.; (41) Podisus spinosus Dall., p., frequents the flowers for entangled insects.

The following visitors may be expected to transfer the pollinia without difficulty:

Hymenoptera.—*Apidæ*, (42) Bombus separatus Cr. ♀ ☿, t.; (43) B. pennsylvanicus DeG. ☿; (44) B. americanorum F. ♀; (45) Melissodes obliqua Say ♂, p. *Eumenidæ*, (46) Odynerus arvensis Sauss., h. *Philanthidæ*, (47) Cerceris bicornuta Guér., h. *Bembecidæ*, (48) Bembex nubillipennis Cr., h. *Sphecidæ*, (49) Pelopœus cementarius, Dru.; (50) Sphex ichneumonea L., h.; (51) Priononyx atrata Lep., p.; (52) P. thomæ F., h. *Scoliidæ*, (53) Myzine sexcincta F., h.; (54) Scolia bicincta F., h.

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* Kindly determined for me by Prof. G. H. French.

Lepidoptera.—*Rhopalocera*, (55) Papilio philenor L.; (56) P. asterias F.; (57) Colias philodice Godt.; (58) Danais archippus F., h.; (59) Argynnis idalia Dru.; (60) A. cybele F., h.; (61) Grapta interrogationis F., h.t.; (62) Vanessa antiopa L., h.c.; (63) Pyrameis atalanta L., h.; (64) Limenitis disippus Godt.; (65) Eudamus lycidas Sm.-Abb., h.; (66) E. tityrus F.

Diptera.—*Midasidæ*, (67) Midas clavatus Dru., t.

Coleoptera.—*Scarabæidæ*, (68) Trichius piger F.

I have also found these beetles gnawing the flowers: *Melanotus communis* Gyll., *Macrodactylus angustatus* Bv., and *Tetraopes tetraophthalmus* Forst.; plants growing in my yard were freed from the latter pest by the rose-breasted grossbeak, *Habia ludoviciana*.

Of the 39 species bearing pollinia of this *Asclepias*, 20 have the corpuscula on the hairs of their legs, 15 have them on their pulvilli, 6 have corpuscula attached to their tongues, and 5 have them attached to their claws.

Asclepias Sullivantii Engelm.—The insect visitors of this plant were observed on 25 days, between June 22 and Aug. 20. The anther wings are much longer and stronger than in *A. Cornuti*, and the hoods are deeper. Accordingly, the number of insects which can pollinate the flower with safety is not so great.

Insects of the following species were found dead on the flowers; they must, therefore, be regarded as not adapted to the flowers, although some of them may sometimes effect pollination:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, and one ♂, c.p.t.; (2) Xenoglossa pruinosa Say ♂, c., one; (3) Megachile infragilis Cr. ♂, c., one; (4) M. brevis Say ♂ ♀, c. *Andrenidæ*, (5) Halictus lerouxii Lep. ♂, p.c.; (6) H. ligatus Say ♂, c.; (7) H. fasciatus Nyl. ♂, c. *Larridæ*, (8) Astata unicolor Say, one. *Sphecidæ*, (9) Isodontia philadelphica Lep., h.c., one.

Diptera.—*Bombylidæ*, (10) Sparnopolius fulvus Wied., one. *Syrphidæ*, (11) Eristalis æneus F., c., one; (12) Syritta pipiens L., one. *Muscidæ*, (13) Lucilia cornicina F.

Lepidoptera.—*Rhopalocera*, (14) Pamphila peckius Kby., p. *Pyralidæ*, (15) Scepsis fulvicollis Hübn.

Coleoptera.—*Scarabæidæ*, (16) Trichius piger F., c.

This list plainly indicates that only the largest insects are adapted to transfer the pollen of this *Asclepias*.

The following insects either do not extract the pollinia at all, or could not be expected to do so often:

Hymenoptera.—*Apidæ*. (17) Ceratina dupla Say; (18) Megachile relativa Cr. ♀. p.c., one; (19) Cœlioxys 8-dentata Say ♂ ♀. *Andrenidæ*, (20) Augochlora pura Say ☿ ♀: (21) A. labrosa Say ♂ ♀: (22) A. lucidula Sm. ♀; (23) Sphecodes arvensis Patton. *Eumenidæ*, (24) Odynerus arvensis Sauss. *Crabronidæ*. (25) Crabro rufifemur Pack.. one. *Philanthidæ*, (26) Cerceris clypeata Dahlb. *Larridæ*, (27) Lyroda subita Say. *Scoliidæ*, (28) Myzine sexcincta F. *Ichneumonidæ*. (29) Ichneumon flavizonatus Cr.. one. with corpusculum on antenna!

Diptera.—*Syrphidæ*, (30) Tropidia quadrata Say. *Tachinidæ*, (31) Micropalpus sp.; (32) Frontina sp.

Lepidoptera.—*Rhopalocera*, (33) Phyciodes tharos Dru.; (34) Thecla humuli Harr.; (35) T. titus F., h.. one; (36) Chrysophanus thoe. Bd.-Lec.; (37) Lycæna comyntas Godt.: (38) Pamphila cernes Bd.-Lec. *Ægeriadæ*, (39) Ægeria æmula Hy. Edw.

The following visitors seem to me to be the only ones adapted to the flower:

Hymenoptera.—*Apidæ*. (40) Bombus separatus Cr. ♀ ☿, sp.c.; (41) B. pennsylvanicus DeG. ☿ ☿. sp., p.c. t.; (42) B. scutellaris Cr. ☿. *Bembecidæ*. (43) Bembex nubillipennis Cr., c. *Sphecidæ*. (44) Pelopœus cementarius Dru.. c.; (45) Priononyx thomæ F.. h.

Lepidoptera.—*Rhopalocera*. (46) Papilio asterias F., c.; (47) Colias philodice Godt.. c.; (48) Danais archippus F., sp.. h.c.; (49) Argynnis cybele F.; (50) Pyrameis atalanta. L.

Finally. the structure of the hoods seem to indicate an adaptation to bumble-bees, and I suspect that before the appearance of the hive-bee the flowers depended mainly upon *Bombus separatus*.

I have also seen the flowers visited by the ruby-throated humming-bird. *Podisus spinosus* Dall. frequents the flowers to prey upon entangled insects.

Of the 22 species of insects bearing corpuscula of this *Asclepias*, 18 have the corpuscula attached to their claws, 4 have them on the hairs of their legs, 5 have them on their pulvilli, 3 bear them on their tibial spurs, 2 have corpuscula on their tongues, and 1, by accident, has a corpusculum attached to the tip of its antenna.

Asclepias tuberosa L.—The following visitors were taken on this butterfly flower:

Lepidoptera.—*Rhopalocera*, (1) Papilio philenor L.. h.; (2) P. asterias F., h.; (3) P. troilus L., h.; (4) Pieris protodice Bd.-Lec., h.; (5) Colias philodice Godt., h., (6) Danais archippus F.; (7) Argynnis idalia Dru., h.; (8) A. cybele F., h.; (9) Phyciodes tharos Dru.; (10) Thecla titus F.; (11) Chrysophanus thoe Bd.-Lec.; (12) Lycæna comyntas Godt. *Pyralidæ*. (13) Scepsis fulvicollis Hübn., h.

Hymenoptera.—*Apidæ*. (14) Apis mellifica L. ☿. h.; (15) Megachile brevis Say ♂ ♀; (16) M. montivaga Cr. ♀; (17) Cœlioxys 8-dentata Say ♀. h.c. *Andrenidæ*. (18) Augochlora humeralis Patton ♀. c. *Sphecidæ*. (19) Ammophila intercepta Lep., h.; (20) Sphex ichneumonea L. h.; (21) Priononyx thomæ F., h.; (22) P. atrata Lep.

Diptera.—*Tachinidæ*. (23) Acroglossa hesperidarum Will., h.

I have also seen the flowers visited by the ruby-throated humming-bird, *Trochilus colubris* L.

Of the 15 species bearing pollinia of this plant, 14 have corpuscula fastened to the hairs of their legs, 2 have them on their claws.

Asclepias purpurascens L.— This is also a butterfly-flower. I have found it visited by the following insects:

Lepidoptera.—*Rhopalocera*, (1) Papilio philenor L.; (2) P. cresphontes Cram.; (3) Colias philodice Godt.; (4) Danais archippus F.; (5) Argynnis idalia Dru., h.; (6) A. cybele F., h.; (7) Melitæa phæton Dru., h.; (8) Pyrameis atalanta L., h.; (9) Thecla acadica Edw.; (10) T. calanus Hübn.; (11) Chrysophanus thoe Bd.-Lec.; (12) Lycæna comyntas Godt.; (13) Pamphila zabulon Bd.-Lec.; (14) P. peckius Kby.; (15) P. cernes Bd.-Lec.; (16) P. verna Edw.; (17) P. manataaqua Scud.; (18) Eudamus pylades Scud., h.

Hymenoptera.—*Apidæ*. (19) Apis mellifica L. ☿, h.; (20) Bombus separatus Cr. ♀; (21) B. vagans Sm. ♀; (22) B. americanorum F. ♀; (23) Anthophora abrupta Say ♂ ♀. *Andrenidæ*, (24) Augochlora pura Say ♀; (25) Halictus confusus Sm. ♀. *Sphecidæ*, (26) Priononyx atrata. Lep.

Diptera.—*Tachinidæ*. (27) Acroglossa hesperidum Will., h.

Hemiptera.—*Lygæidæ*. (28) Lygæus fasciatus Dall., h.

The flowers are also visited for honey by the humming-bird, *Trochilus colubris* L., and are gnawed by *Tetraopes tetraophthalmus*.

The 8 species of insects bearing pollinia of this *Asclepias* have the corpuscula attached only to their tarsal hairs.

Acerates longifolia Ell.—The list of visitors was observed on 19 days, between July 5 and Aug. 1. The names of the insects are followed by f., l., t., or v.s., according as the corpuscula were found attached to the hairs of the face, labrum, tongue, or ventral surface.

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, v.s.; (2) Bombus separatus Cr. ♂ ♀ ☿, ab., l., t., v.s.; (3) B. scutellaris Cr. ☿, ab., v.s.; (4) Megachile brevis Say ♀; (5) M. mendica Cr. ♀, v.s. *Vespidæ*, (6) Polistes pallipes Lep. *Eumenidæ*, (7) Odynerus arvensis Sauss. *Philanthidæ*, (8) Cerceris bicornuta Guér., f., t., v.s.; (9) C. compar Cr. *Bembecidæ*, (10) Bembex nubillipennis Cr., ab., l. *Sphecidæ*, (11) Priononyx atrata Lep., v.s. *Pompilidæ*, (12) Priocnemis unifasciatus Say, t., v.s.; *Scoliidæ*, (13) Myzine sexcincta F.

Coleoptera.—*Scarabæidæ*, (14) Trichius piger F., v.s.

Lepidoptera.—*Rhopalocera*, (15) Thecla sp.; (16) Chrysophanus thoe Bd.-Lec. *Pyralidæ*, (17) Scepsis fulvicollis Hübn.

GENTIANACEÆ.

Gentiana Andrewsii Griseb.*—The flowers are proterandrous. They remain closed, so that only the largest and most intelligent bees can open them. The stamens are united with the corolla tube, and their free ends bend over upon the pistil. To reach the nectar the bee's tongue must be thrust between the filaments and must be 15 or 16 mm. long. The flower is visited abundantly by *Bombus americanorum* F. ♂ ♀ ☿.

There is no doubt that flowers were originally of such a form that almost any insects could enter them and reach the nectar. Many have narrowed the entrance by the development of tufts of hair, or of processes like the palates of personate flowers, until all insects were excluded except bees. These have kept on visiting the flowers until now they enter completely closed flowers like those of *Linaria*.

They seem to have been trained to bad habits in this way, for they sometimes force their way into flowers which are not yet ready to receive them. I have mentioned the case of *Bombus vagans* forcing her way into the closed buds of *Triosteum perfoliatum*, and *B. americanorum* does the same in the case of buds of *Linaria vulgaris*. Mr. Pammel refers to a number of cases in which flower-buds have been opened or perforated by insects.† The irregular behavior in such cases is not to be laid

* See Beal, Am. Nat. viii. 180, and Vausenburg, ibid. ix. 310.

† On the Perforation of Flowers, Trans. St. L. Acad. Sci. v. 255, note.

to the blame of the insects, but to the flower itself, which secretes its nectar prematurely.

A habit on the part of the visitor of forcing its way into a flower before it is fairly open might result in a form like the present, especially when a set of intruders might be excluded without interfering with the proper visitors.

POLEMONIACEÆ.

Phlox divaricata L.—The narrow tubes are about 14 or 15 mm. long. The flowers are adapted to lepidoptera, but are sometimes visited by long-tongued bees. On 11 days, between April 26 and May 19, I observed the following visitors:

Hymenoptera.—*Apidæ*, (1) Bombus virginicus Oliv. ☿; (2) B. vagans Sm. ☿; (3) B. americanorum F. ♀; (4) Synhalonia speciosa Cr. ♀.

Lepidoptera.—*Rhopalocera*, (5) Danais archippus F.; (6) Papilio philenor L.; (7) P. asterias F.; (8) P. troilus L.; (9) P. turnus L.; (10) Colias philodice Godt.; (11) Pamphila zabulon Bd.-Lec. vars. hobomok Harr. & quadraquina Scud.; (12) Nisoniades icelus Lintn.; (13) Eudamus bathyllus Sm.-Abb. *Sphingidæ*, (14) Hemaris thysbe F.; (15) Deilephila lineata F.

Polemonium reptans L.—The flowers are proterandrous as in *P. cœruleum*,* which it resembles in most respects. The upper part of the tube has a few purplish lines which serve as pathfinders. The flowers commonly turn to one side, so that insects land upon the stamens and prefer to insert their tongues between the upper ones. The upper stamens are a little shorter; consequently, their anthers do not come in the way of the lower ones when a bee rests upon them.

In the Alps, Müller found *P. cœruleum* visited by workers of 5 species of *Bombus*, but I have never seen a *Bombus* worker flying while *P. reptans* was in bloom. In low Germany bumblebees were not observed among the visitors of *P. cœruleum*.

On 6 days, between April 20 and May 7, I observed the following visitors:

Hymenoptera.—*Apidæ*. (1) Apis mellifica L. ☿, s. & c.p.†; (2) Bombus americanorum F. ♀, s., ab.; (3) B. vagans Sm. ♀, s.; (4) Synhalonia

* For references see Müller: Fertilization of Flowers, 407.

† ♂, male; ♀, female; ☿, worker; s, sucking; c.p., collecting pollen; f.p., feeding on pollen; ab., abundant.

honesta Cr. ♀, s.; (5) Alcidamea producta Cr. ♂, s.; (6) Osmia albiventris Cr. ♀, s. & c.p.; (7) Nomada luteola Lep. ♂, s. *Andrenidæ*, (8) Augochlora pura Say ♀, s. & c.p.; (9) Andrena, sp. ♂, s.; (10) A. sayi Rob. ♀, c.p.; (11) A. polemonii Rob. ♂ ♀, s. & c.p.; (12) Halictus pilosus Sm. ♀, s. & c.p.

Diptera.—*Syrphidæ*, (13) Mesograpta marginata Say, f.p.; (14) Rhingia nasica Say, s. & f.p.

Lepidoptera —*Rhopalocera*, (15) Colias philodice Godt., s.; (16) Nisoniades brizo Bd.-Lec., s.

Coleoptera.—*Coccinellidæ*, (17) Megilla maculata DeG., f.p.

HYDROPHYLLACEÆ.

*Hydrophyllum Virginicum** L.—The flowers are male in the first stage. The stigma, when receptive, surpasses the anthers. On account of the erect corolla lobes and the hairy filaments, the nectar can be obtained most conveniently by a tongue about 9 mm. long.

May 11, 12, 21 and 23 I observed the following visitors:

Hymenoptera.—*Apidæ*, (1) Bombus virginicus Oliv. ♀; (2) B. ridingsii Cr. ♀, ab.; (3) B. vagans Sm. ♀; (4) B. americanorum F. ♀; (5) Anthophora abrupta Say ♀—all s. *Andrenidæ*, (6) Augochlora pura Say ♀, c.p.

Diptera.—*Syrphidæ*, (7) Rhingia nasica Say, f.p.

Hydrophyllum appendiculatum Michx.—The flowers are proterandrous as in the preceding. They are pale blue with white centres. The throat is more widely open than in *H. Virginicum*, and the filaments are not hairy. There is, therefore, less difficulty in reaching the nectar. Accordingly, we find more short tongues, although bumble-bees remain by far the most numerous guests. The flowers and flower-clusters are much more conspicuous, and the plants grow in larger patches.

May 3, 14 and 16 I observed the following visitors:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, s. & c.p., ab.; (2) Bombus virginicus Oliv. ♀ ☿, s.; (3) B. separatus Cr. ♀ ☿, s. & c.p., ab.; (4) B. ridingsii Cr. ♀ ☿, s. & c.p., ab.; (5) B. vagans Sm. ♀, s.; (6) B. americanorum F. ♀, s., ab.; (7) Synhalonia honesta Cr. ♂ ♀, s. & c.p., ab.; (8) S. speciosa Cr. ♂, s.; (9) Megachile brevis Say ♂, s., once; (10) Osmia lignaria Say ♀, s., ab.; (11) O. albiventris Cr. ♀, s. & c.p., ab. *Andrenidæ*, (12) Andrena erigeniæ Rob. ♂ ♀, s. & c.p.;

* See Sprengel, "Das entdeckte Geheimniss," 104, Tab. xix. 46 & 47.

(13) Agapostemon radiatus Say ♀, s. & c.p.; (14) Augochlora pura Say ♀, s. & c.p., ab.; (15) A. lucidula Sm. ♀, s., once; (16) Halictus 4-maculatus Rob. ♀, s., once; (17) H. pectoralis Sm. ♀, s.; (18) H. coriaceus Sm. ♀, s., ab.; (19) H. pilosus Sm. ♀, s., once; (20) H. confusus Sm. ♀, s., once. *Eumenidæ*, (21) Odynerus tigris Sauss., s.; (22) O. foraminatus Sauss., s.

Diptera.—*Empidæ*, (23) Empisnuda Lw., s., ab. *Syrphidæ*, (24) Rhingia nasica Say, s. & f.p., ab.; (25) Eristalis flavipes Walk., s.; (26) Criorhina intersistens Walk., s.; (27) Xylota chalybea Wied. *Anthomyidæ*, (28) Anthomyia sp.

Lepidoptera.—*Rhopalocera*, (29) Phyciodes nycteis D. & H.; (30) Pamphila zabulon Bd.-Lec.; (31) Pholisora hayhurstii Edw.—all s.

BORRAGINACEÆ.

Mertensia Virginica DC.—I have found the flowers open on four or five successive days. On the morning of the first day the anthers are still closed, while the stigma appears receptive. On the second day, and sometimes on the third, the anthers discharge their pollen. Then the flowers hang on for a day or two, adding to the conspicuousness of the inflorescence. The flowers are hardly to be regarded as proterogynous, cross-fertilization being secured by the stigma being widely separated from the anthers and striking the bee in advance of them.

Nectar is secreted by four glands alternating with the carpels. The style is somewhat flattened at base, and the carpels are in pairs on each side of it. In the wider intervals thus formed, two of the glands are situated, and are much larger than the others, rising as high as the carpels.

The bell-shaped border opens into a tube which is from 14 to 15 mm. long. The blue color and the size of the tube, together with the pendulous position of the flowers, indicate an adaptation to the larger bees, but butterflies sometimes hang on the flowers and draw out their honey. In the following list all of the insects are intruders except *Bombus*, *Anthophora*, and *Synhalonia*.

On 16 days, between April 19 and May 13, I observed the following visitors:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, c.p.; (2) Bombus separatus Cr. ♀, s.; (3) B. ridingsii Cr. ♀, s.; (4) B. vagans Sm. ♀, s.; (5) B. americanorum F. ♀, s.; (6) B. pennsylvanicus DeG. ♀, s.; (7) Anthophora abrupta Say ♂ ♀, s.; (8) A. ursina Cr. ♂ ♀, s.; (9)

Synhalonia speciosa Cr. ♀, s.; (10) S. honesta Cr. ♀, s.; (11) S. atriventris Sm. ♂, s.; (12) Osmia albiventris Cr. ♀, c.p. *Andrenidæ*. (13) Augochlora pura Say ♀; (14) Halictus confusus Sm. ♀—both crawling into tube.

Lepidoptera.—*Rhopalocera*, (15) Danais archippus F.; (16) Pyrameis atalanta L.; (17) Papilio troilus L.; (18) Nisoniades juvenalis F.—all s. *Sphingidæ*. (19) Hemaris thysbe F., s.

Diptera.—*Bombylidæ*, (20) Bombylius fratellus Weid., s. *Syrphidæ*. (21) Rhingia nasica Say. s. & f.p.; (22) Teuchocnemis literatus Lw., f.p.

According to Schneck,* this flower is perforated by a bumble-bee—either *B. americanorum* or *B. pennsylvanicus*. Only female bumble-bees fly while *Mertensia* blooms, and, since the females of both of these bees can easily drain deeper flowers, I see no reason why they should make holes in this flower.

CONVOLVULACEÆ.

Ipomœa pandurata Meyer.—Insects can crawl into the tube of the corolla as far as three centimetres. The nectar, which is secreted by a fleshy disc surrounding the base of the ovary, is concealed by the broad, hairy bases of the filaments, between which bees must insert their proboscides. The stamens are of unequal length, so that some of the anthers reach beyond the stigma.

The flowers are very large and white, with purple in the bottom of the tube. A proboscis 14 mm. long can reach all of the nectar. The flower is visited mainly by a remarkable assemblage of bees of characteristic American genera. The following were observed on eight days, between July 11 and Aug. 26:

Apidæ, (1) Bombus separatus Cr. ♂, s.; (2) B. americanorum F. ♀ ☿, s.; (3) Entechnia taurea Say ♂ ♀, s., ab.; (4) Emphor bombiformis Cr. ♂, s., one; (5) Xenoglossa ipomœæ Rob. ♂ ♀, s., ab.; (6) X. pruinosa Say ♂ ♀, s., ab.; (7) Melissodes bimaculata Lep. ♂ ♀, s. & c.p., ab.

Convolvulus sepium L.—In Europe the distribution and fertility of this plant is supposed to have some relation to the distribution of *Sphinx convolvuli*,† though Müller has found it visited by other insects by day.

On 3 days, between June 29 and July 27, I found it visited in sunlight by the following insects:

Apidæ.—(1) Bombus americanorum F. ♀ ☿, s., ab.; (2) Anthophora abrupta Say ♀, s.; (3) Entechnia taurea Say ♂, s.; (4) Melissodes bimaculata Lep. ♂, s.; (5) Ceratina dupla Say ♀, s.

* Bot. Gazette, xii. 111; xiii. 39.

† Fertilization of Flowers, 424.

SOLANACEÆ.

Solanum nigrum L.—The flowers are specially adapted to bumble-bee females, which visit them only to collect pollen, which they milk out of the apical chinks of the anthers with their jaws, as in the case of *Cassia*. Sprengel saw bees and bumble-bees collecting pollen. Müller saw *Melithreptus* (=Sphærophoria) *scriptus* and *Syritta pipiens* feeding on the pollen. The visits of these *Syrphidæ*, I think, have little significance, since they often visit flowers to which they are not adapted in order to feed upon stray pollen. In Florida, Feb'y 24, 1887, I saw *Bombus virginicus* Oliv. ♀ collecting the pollen. In Illinois I saw the flowers visited by *Bombus virginicus* ☿ and by *B. americanorum* F. ♀.

Solanum Carolinense L.— Like the preceding, this flower is adapted to bumble-bee females, which visit it only for pollen. I have seen *Bombus americanorum* F. ☿ collecting the pollen.

*Datura Tatula** L.—("Adv. from trop. Amer.") The flower measures about 11 centimetres. The stamens are adherent to the corolla tube for about 40 mm., after which they extend inward to the middle, so that bees are excluded from the honey and only *Sphingidæ* can reach it. I have seen *Deilephila lineata* F. sucking.

Hive-bees squeeze into the flower-buds as soon as they begin to open, and collect all of the pollen before the time of flight of hawk-moths. I have seen most of the pollen carried away as early as five o'clock in the afternoon. I have seen the following insects visiting the flower for pollen :

Hymenoptera.—*Apidæ*, (1) Apis mellifica F. ☿, ab.; (2) Melissodes perplexa Cr. ♀. *Andrenidæ*, (3) Halictus confusus Sm. ♀—all c.p.

Diptera. — *Syrphidæ*, (4) Syrphus ribesii L.; (5) Allograpta obliqua Say; (6) Mesograpta marginata Say; (7) Rhingia nasica Say—all f.p.

Coleoptera.—*Chryosmelidæ*, (8) Diabrotica 12-punctata Oliv., f.p.

Of course all of the insects mentioned above, except the *Deilephila*, must be regarded as intruders. The plant probably depends mainly upon self-fertilization and has spread beyond the range of its principal pollinators. The above-mentioned insects may aid in self-fertilization or cross-fertilization, but their visits only result from the flower opening prematurely.

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* On *D. Stramonium* see Sprengel, 122, and Schulz. Beiträge zur Kenntniss der Bestäbuungseinrichtungen u. d. Geschlechtevertheilung b. d. Pflanzen, 73.

SCROPHULARIACEÆ.

Verbascum Thapsus L.- ("Nat. from Eur.")—In a paper on "Zygomorphy and its Causes."* I have assumed that when the perianth of lateral flowers failed to protect the stamens, either on account of its shortness or its wide expansion, insects would alight upon the stamens in preference to other parts of the flower, and in this way I endeavored to explain the origin of flowers which dust the visitor upon the ventral surface. It was my desire to discuss the irregularity of *Verbascum* in connection with that of *Scrophularia*, but I could not venture to do so because I had made no direct observations upon it, and because the observations which had been made by Müller did not clearly conform with my views. I have also criticised Prof. Henslow† for claiming that *Verbascum* is in the first stage of irregularity, but I was not then prepared to assert that the quotation which he made from Müller did not describe the true relations which visiting insects hold to different parts of the flower. Indeed, my statements rest upon the observation of *V. Thapsus* and *Blattaria* alone, and upon inferences drawn from Müller's lists.

I suppose the prototype of *Verbascum* to have been a bilabiate flower with didynamous stamens, because the type of the order is didynamous and because the two genera which with *Verbascum* form the tribe *Verbasceæ* have only four stamens. The flower was originally adapted to long-tongued bees which visited it for nectar, alighting upon the lower lip and striking their backs against the anthers. The stamens were included, holding their anthers against the upper wall of the corolla in such a position that flies and small bees would hardly be able to get at the pollen. Then the flower became more widely expanded, exposing the stamens so that the insects could easily alight upon them and eat or collect the pollen. The fifth stamen, being no longer crowded in the upper part of a narrow tube, regained its antheriferous function and joined the other four in their new position on the lower side. Then the flower, being fertilized mainly by insects coming for pollen, began to reduce its nectar supply.

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* Bot. Gazette xiii. 146, 203, 224.

† Bot. Gazette xiii. 324; xiv. 134-36. And Henslow: Origin of Floral Structures, 118.

The quotation which Henslow makes from Müller* is in regard to *V. nigrum* and reads as follows: "The short tube widens out into a flat, five-lobed limb, which takes up an almost vertical position: the inferior lobe is the longest, and the two superior are shorter than the lateral lobes, so that an insect settles most conveniently upon the inferior. The stamens project almost horizontally," etc. From the relative positions of the limb and stamens, one would expect insects to prefer the latter as a resting-place. For some time Müller supposed *V. nigrum* contained no honey, but he afterwards found it. Of the visitors which he observed, 3 came for honey, 6 for pollen, and 1 for both honey and pollen; so that most of them were after pollen, and would most probably alight directly upon the stamens. Of 6 visitors of *V. phœnicium*, 5 were in search of pollen, and 1 vainly sought for nectar. Of 10 visitors of *V. Thapsus*, 7 were after pollen, and 3 "semeed to be sucking." Of 15 guests observed by me on *V. Thapsus*, all visited the flower exclusively for pollen, and invariably settled upon the stamens.

There seems, therefore, to be no reason for supposing, as Henslow does, that *Verbascum* is in the first stage of irregularity, and that insects use the lower lobes of the corolla as a landing-place. By exposing its stamens, the flower has changed from *nototribe* to *sternotribe*, from dusting its visitors upon their backs to dusting them upon the ventral surface. In this connection it may be well to mention that Delpino† has pointed out that *Verbascum* is adapted to pollen-collecting bees, and that the hairs upon the stamens are for the bees to cling to when gathering pollen.

The following visitors were observed on 6 days, between June 27 and July 9:

Hymenoptera.—*Apidæ* (1) Apis mellifica L. ☿,; (2) Bombus americanorum F. ☿. *Andrenidæ*. (3) Agapostemon nigricornis F. ♀; (4) Augochlora lucidula Sm. ♀; (5) Halictus pectoralis Sm. ♀ (6) H. coriaceus Sm. ♀; (7) H. confusus Sm. ♀: (8) H. cressonii Rob. ♀—all c.p.

Diptera.—*Syrphidæ*, (9) Pipiza pistica Will.: (10) *Syrphus americanus* Wied.; (11) Allograpta obliqua Say; (12) Mesograpta marginata Say; (13) M. geminata Say; (14) Syritta pipiens L.—all f.p. *Anthomyidæ*, (15) Anthomyia sp., f.p.

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* Fertilization of Flowers, 429.

† Ulteriori osservazioni.

Linaria vulgaris Mill.* ("Nat. from Eu.")—That the flower is adapted to long-tongued bees is not only indicated by the size of the tube and the length of the spur, but by the fact that only the larger bees are able to open the flower with ease. I have seen a large bee, *Bombus americanorum*, visit 62 flowers in five minutes. When a bumble-bee alights upon the palate, its weight opens the flower, and all it has to do is to enter. But the other bees observed by me are not heavy enough to open the flower by their own weight, and so can only enter by squeezing in between the lips. Thus, I have seen the hive-bee enter so as to strike the stamens with its ventral surface or with its side, although it often brings its back against them. *Megachile brevis* ♀ goes into the flower upside down, but she may do so intentionally, so as to bring her ventral scopa in contact with the anthers, as she is in the habit of doing on many flowers which are adapted to dust their visitors upon the back.

Müller observed bees only on the flowers, but I have seen four butterflies stealing honey. They insert their thin proboscides between the closed lips with very little chance of touching the anthers or stigma. In the next species the tube is so contracted that butterflies can be utilized for transferring pollen. I regard all of the visitors of *L. vulgaris* as intruders, except *Bombus*.

On 8 days, between June 25 and Oct. 10, I observed the following visitors:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, s. & c.p.; (2) Bombus vagans Sm. ☿, s.; (3) B. americanorum F. ♂ ♀ ☿, s. & c.p., ab.; (4) B. virginicus Oliv. ☿, s. & c.p., one; (5) Megachile brevis Say ♀, c.p.; (6) Alcidamea producta Cr. ♀, s. and sometimes c.p., when it reverses to bring ventral scopa against anthers. *Andrenidæ*, (7) Agapostemon nigricornis F. ♀, s., one.

Lepidoptera.—*Rhopalocera*, (8) Pyrameis cardui L.; (9) Pieris rapæ L.: (10) Colias philodice Godt.: (11) Pamphila cernes Bd.-Lec.—all s.

Linaria Canadensis Spreng.—I have given some account of this plant, comparing it with other species of the genus.† The tubular portion of the corolla is contracted so that bees cannot enter as in *L. vulgaris*, and the nectar is thus comparatively

* See Müller. Fertilization of Flowers, 431.

† Bot. Gazette, xiii. 228.

more deeply concealed. The tube measures about 3 mm. and the spur about 6 mm., so that a long tongue is necessary to drain it. The spur is very slender—a character which favors butterflies, which are the most abundant visitors. Small bees can reach some of the nectar. On account of the weakness of the palate, flies sometimes suck up the honey, or feed upon the pollen.

At Orlando, Fla., the following visitors were observed on 7 days, between Feb. 17 and March 20:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿; (2) Megachile brevis Say ♂♀; (3) Anthidium perplexum Sm. ♂; (4) Nomada torrida Sm. ♀. *Andrenidæ*, (5) Agapostemon aëruginosus Sm. ♀; (6) Augochlora sumptuosa Sm. ♀; (7) A. lucidula Sm. ♀; (8) Halictus pectoralis Sm. ♀; (9) H. capitosus Sm. ♀; (10) H. creberrimus Sm. ♀. *Scoliidæ*, (11) Elis 4-notata F. ♂♀—all s.

Lepidoptera.—*Rhopalocera*, (12) Phyciodes tharos Dru.; (13) Pyrameis huntera F.; (14) Junonia cœnia Hübn.; (15) Calephelis cænius L.; (16) Papilio philenor L.; (17) P. ajax L.; (18) Callidryas eubule L. (19) Terias lisa Bd.-Lec. (20) Pamphila eufala Edw.; (21) P. huron Edw.; (22) P. brettus Bd.-Lec.; (23) P. cernes Bd.-Lec.; (24) Eudamus sp. *Bombycidæ*. (25) Utetheisa bella L.—all s.

Diptera.—*Bombylidæ*, (26) Toxophora amphitea Walk., s. *Syrphidæ*, (27) Mesograpta marginata Say; (28) Baccha clavata F. (=B. babista Walk.)—both f.p.

Scrophularia nodosa L., var. *Marilandica* Gray.—In the Torrey Bulletin, viii. 133–140, Prof. Trelease has given a complete account of the fertilization of *Scrophularia* with references to the special literature.*

The flower is interesting on account of its special adaptation to wasps. Müller found it visited by 12 species of insects, of which 6 were *Vespidæ* and 6 bees.† I have found it visited by 14 species of bees, 11 *Vespidæ* and *Eumenidæ*, and 8 species of other families. Although more bees were observed on the flowers, the proportion of wasps is remarkable. I have found as many species on other plants, but never in such proportions. Indeed, I have taken 15 species of *Vespidæ* and *Eumenidæ* on flowers of *Cicuta maculata*, but the total number of hymenoptera was 143. Again, I took 14 species on *Pastinaca sativa*, but with 113 other

* See also T. W. Fulton, Gardener's Chronicle, Jan. 2, 1886; and Foerste, Bot. Gazette, xiii. 153.

† Fertilization of Flowers, 436; and Weit. Beobachtungen, iii. 30.

hymenoptera. The fact that they hold a proportion of over one-third in the list of *Scrophularia* is sufficient evidence that the flower specially favors wasps. I know of no bee-flower on which so many wasps occur as intruders. On the other hand, it is but natural that bees should intrude in a wasp-flower, since it is fairly impossible to construct a wasp-flower from which bees would be entirely excluded.

It certainly is not true that the flowers are not easily discovered by bees, and that the nectar is not attractive to them. Sometimes hive-bees are present in great numbers, and are about the only visitors to be seen.* Sometimes bumble-bee workers are equally abundant, and no wasps will be observed. On the contrary, in the latter part of August and first of September, when the number of flowers is reduced, I have fonnd *Vespa maculata* and *V. germanica* to be the only visitors. This seems to be significant, for, when any flower becomes reduced in numbers, its proper visitors are apt to be the last to leave it.

The *Syrphidæ* and the *Halictus* females visit the flowers mainly for pollen, and, as Prof. Trelease has observed in the case of the latter, they often pay more attention to the flowers in the male stage; but the male *Halictus* and the larger bees visit the flowers for nectar.

On 15 days, between July 12 and September 19, I observed as visitors:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, s., ab.; (2) Bombus virginicus Oliv. ☿, s. & c.p., ab.; (3) B. vagans Sm. ♂ ♀; (4) Melissodes bimaculata Lep. ♂ ♀; (5); Ceratina dupla Say ♀; (6) Megachile montivaga Cr. ♀; (7) M. infragilis Cr. ♂—all five s. *Andrenidæ*, (8) Agapostemon nigricornis F. ♂, s.; (9) Augochlora pura Say ♂ ♀, s. & c.p.; (10) Halictus coriaceus Sm. ♂ ♀. s. & c.p.; (11) H. lerouxii Lep. ♀, s. & c p.; (12) H. fasciatus Nyl. ♂ ♀, s. & c.p.; (13) H. zephyrus Sm. ♂, s.; (14) H. confusus Sm. ♂ ♀, s. & c.p. *Vespidæ*, (15) Vespa maculata L.; (16) V. germanica F.; (17) Polistes rubiginosus Lep.; (18) P. metricus Say. *Eumenidæ*, (19) Zethus spinipes Say; (20) Eumenes fraternus Say; (21) Odynerus campestris Sauss.; (22) O. foraminatus Sauss.; (23) O. conformis Sauss.; (24) O. anormis Say; (25) O. pedestris Sauss.; (26) O. pennsylvanicus Sauss. *Philanthidæ*, (27) Philanthus punctatus Say. *Sphecidæ*, (28) Ammophila vulgaris Cr.—all s.

* See Farlow in Amer. Jour. Sci. & Arts, 1871, 3d ser. ii. 151. The plant is, in fact, known in parts of the West as "Simpson's Bee-plant."

Diptera.—*Syrphidæ*. (29) Mesograpta polita Say; (30) M. marginata Say—both f.p.

Lepidoptera.—*Rhopalocera*. (31) Lycæna comyntas Godt. *Pyralidæ*. (32) Scepsis fulvicollis Hübn.

Birds.—*Trochilidæ*, (33) Trochilus colubris L., s. on four days.

Collinsia verna Nutt.*—The plants rise from 3 to 10 inches high and grow in rather large patches, so that the flowers are rendered quite attractive to insects.

The flower resembles a papilionaceous flower in a striking manner. The two-lobed upper lip is white and rises nearly vertically, resembling a vexillum. Below, it is provided with a palate which rests upon the lower lip and forms quite a barrier against unbidden guests, and also requires the visitors to depress the lower lip in order to reach the sweets. The palate is provided with brownish spots which form path-finders. The lower lip is blue. Its lateral lobes represent the wings, and the middle lobe, which is folded longitudinally, corresponds to the keel of a papilionaceous flower.

The four stamens arise on the upper wall of the corolla, but their filaments extend across the tube, their anthers being enclosed in the infolded lobe of the lower lip. The filaments with the hairs upon them completely close the tube. Insects land above the filaments, and can only reach the nectar by inserting their proboscides between them. After a bee has forced its head in under the palate, it still requires a tongue about 3 mm. long to reach to the bottom of the tube. The anthers have their broad faces extending vertically, and, on account of the unequal length of the filaments, are arranged in an irregular row, so that they lie as snugly as possible in the keel-like middle lobe of the lower lip.

After the lip has been depressed, it returns to its position enfolding the anthers. The pollen is thus protected from *Syrphidæ*, *Andrenidæ* and beetles, and can only be collected by bees which are strong enough to depress the lip. The anthers discharge their pollen in succession, those of the longer stamens first. Accordingly, in order to collect all of the pollen, bees must visit each flower several times.

* See Müller: Fertilization of Flowers, 436.

The stigma stands among the anthers, and sometimes appears receptive before they discharge. When the lower lip is forced down, the stigma may touch the bee in advance of the anthers; but, in the absence of insects, I find nothing to prevent the stigma from receiving pollen from the surrounding stamens. In Müller's "Fertilization of Flowers," 436, it is stated that, in the absence of insects, flowers of this plant and of *C. bicolor* fertilize themselves, and are fertile to their own pollen.

I regard the flower as specially adapted to early-flying bees with abdominal collecting-brushes— i.e. species of *Osmia*—and these bees, although not the exclusive visitors, are far more abundant and more important than all of the other visitors together. As an illustration of the extent to which the economy of these bees is associated with the flower, may be mentioned the fact that the females of the four species found on the flowers all collected pollen, and that they were the only native bees collecting pollen, except a single individual of *Halictus Lerouxii*. *Bombylius*, *Empis*, and butterflies, are mere intruders, since they can reach the nectar without depressing the lower lip, and so without touching anthers or stigma.

In the order to which it belongs, *Collinsia* is remarkable from the fact that it dusts its visitors on the ventral surface instead of on the back. As in the cases of *Verbascum* and *Scrophularia*,* I suppose that the flower originally applied its pollen to the backs of the bees; then that the flower changed so as to expose its stamens in such a way that insects could alight upon them; then the stamens turned to the lower side, and the flower became further modified to suit bees with abdominal collecting-brushes.

In 1890 I found the flowers in bloom from April 21 to June 1. On four days, between April 21 and May 8, I captured the following visitors:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, s. & c.p.; (2) Bombus americanorum F. ♀, s.; (3) B. ridingsii Cr. ♀, s.; (4) B. separatus Cr. ♀, s.; (5) B. scutellaris Cr. ♀, s.; (6) B. pennsylvanicus DeG. ♀, s.; (7) Anthophora ursina Cr. ♂, s.; (8) Synhalonia speciosa Cr. ♂, s.; (9) S. honesta Cr. ♂, s.; (10) Ceratina dupla Say ♂ ♀, s., freq.; (11) Osmia atriventris Cr. ♂ ♀, s. & c.p., ab.; (12) O. albiventris Cr.

* Bot. Gazette, xiii, 225.

♂♀. s. & c.p., ab.: (13) O. 4-dentata Cr. ♂♀, s. & c.p., ab.: (14) O. dubia Cr. ♀, s. & c.p., two; (15) Nomada bisignata Say ♀. s. *Andrenidæ*, (16) Halictus lerouxii Lep. ♀, c.p.

Diptera.—*Empidæ*, (17–18) Empis spp., s. *Bombylidæ*, (19) Bombylius fratellus Wied., s.

Lepidoptera.—*Rhopalocera*, (20) Colias philodice Godt., s.: (21) Nisoniades brizo Bd.-Lec., s.; (22) N. persius Scud., s.

Pentstemon lævigatus Soland., var. *Digitalis* Gray.—The flower is proterandrous, as in *P. campanulatus*.* In the first stage, the style with its undeveloped stigma lies against the upper wall of the corolla. The anthers are dehiscent; rigid teeth on their edges grate against the thorax of the visitor and aid in sifting out the pollen, which is rather dry. Later the style turns down at the tip, opposing the receptive stigma in the entrance.

On the 21st of June, 1888, I saw a common wasp, *Odynerus foraminatus*, Sauss., ♀, going from one flower to another, and, turning to the base of the tube, cut a hole in one side with her sharp jaws and insert her tongue. Then she cut a hole on the other side and again inserted her tongue. The nectar is lodged on each side of the base of the sterile filament, and the wasp showed remarkable intelligence in making a hole on each side. I found a few flowers perforated on one side, but most of the flowers had two holes. Again, in 1889, I found the same wasp perforating the flowers in widely separated localities. I also saw *Odynerus anormis* Say ♀ sucking at the openings, but I did not see it make any. Darwin† states that he found *P. argutus?* with two holes in the upper side of the base of the corolla, but supposes that they were made by bees.

The corolla tube is so broad that large bees can crawl into it. Below, it is narrowed for about 8 mm., so that it takes a long tongue to drain the nectar. The sterile filament renders the nectar less accessible, and bees are required to insert their proboscides on each side of it.

The flower is intended to be visited only for honey by long-tongued bees, and other insects are to be regarded as intruders. Small bees crawl into the narrow part of the tube far enough to

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* On the genus, see Müller, "Fertilization of Flowers," 434 & 633.

† "Cross and Self-fertilization of Plants," 436. For other cases of perforation of *Pentstemon*, see Pammel, "On the Perforation of Flowers," Trans. St. Louis Acad. Sci. v. 276.

reach some of the nectar, and they might drain it but for the opposition of the sterile filament. Butterflies also steal the honey, but they, as well as the little bees, are by no means certain to touch the anthers and stigmas.

On 10 days, between May 28 and June 26, I observed the following visitors:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿: (2) Bombus americanorum F. ♀ ☿; (3) B. pennsylvanicus DeG. ♀, one; (4) Anthophora abrupta Say ♂ ♀: (5) Synhalonia atriventris Sm. ♀: (6) S. honesta Cr. ♂: (7) S. speciosa Cr. ♀—all s.; (8) Ceratina dupla Say ♀. c.p.; (9) Megachile montivaga Cr. ♂ ♀, s.; (10) M. brevis Say ♀, s.; (11) Alcidamea producta Cr. ♂ ♀, s. & c.p., ♀ reversing to receive pollen in ventral scopa: (12) Osmia albiventris Cr. ♀, s.; (13) O. montana Cr. ♀, s. *Andrenidæ*, (14) Agapostemon nigricornis F. ♀. c.p.; (15) Halictus coriaceus Sm. ♀, c.p.; (16) H. confusus Sm. ♀, c.p.

Lepidoptera.—*Rhopalocera*. (17) Papilio troilus L.: (18) Colias philodice Godt. *Sphingidæ*, (19) Deilephila lineata F.—all s.

Coleoptera.—*Scarabæidæ*. (20) Trichius piger F., f.p.

Mesograpta marginata Say (Syrphidæ) gleans stray pollen, which is scattered upon lower lip.

Pentstemon pubescens Soland.—The flower is male in the first stage, as in the preceding. The corolla tube measures about 15 mm. and is much narrower than in *P. lævigatus*. The narrow part measures about 6 mm. The wide part has two longitudinal folds beneath, which alone almost close the entrance. Then the sterile filament, which is more hairy than in *P. lævigatus*, and the hairs on the lip, also, aid in closing the mouth of the flower. The effect of these modifications is that a longer tongue is required to reach the nectar conveniently.

The flower blooms somewhat earlier than the foregoing and marks the time of appearance of the males of *Anthophora abrupta*, which are the principal visitors, as far as I have observed. This bee only inserts its head far enough to hide its eyes, and receives the pollen on its hairy face.

On 6 days, between May 12 and June 3, I captured the following insects on the flowers:

Hymenoptera.—*Apidæ*, (1) Bombus vagans Sm. ♀: (2) B. americanorum F. ♀; (3) Anthophora abrupta Say ♂, ab.; (4) Synhalonia speciosa Cr. ♀; (5) S. honesta Cr. ♂; (6) Ceratina dupla Say ♀, crawling into tube; (7) Alcidamea producta Cr. ♂, do.; (8) Osmia atriventris Cr. ♂ ♀, do.; (9) O. distincta Cr. ♀. do.

Lepidoptera. *Rhopalocera*, (10) Papilio philenor L.; (11) P. asterias F.; (12) Pamphila zabulon Bd.-Lec.

Diptera.—*Bombylidæ*. (13) Bombylius atriceps Lw.—all s.

Gratiola Virginiana L.—The plants grow in thin patches in wet places, and rise about a span high. The flowers are white with the tubes greenish-yellow, the upper wall being densely bearded with yellow hairs. The tubes measure about 8 mm. and are strongly curved upward, so that the bee must turn with its ventral surface toward the anthers in order that its body may fit the tube. Then the dense beard on the upper wall also opposes a bee trying to enter right-side up. But the flower is so nearly erect, and the tube is so strongly curved, that the large upper lip stands almost horizontally, forming a most convenient landing-place. Consequently, it is easier for the bee to enter back downwards than in any other way.

While, therefore, the flower has the appearance of a *nototribe* flower, and no doubt was originally of that kind, the form of the tube has been changed so as to make the flower *sternotribe* by requiring the bee to reverse. Delpino has observed the same thing in *G. officinalis*. The curvature of the tube also has the effect of excluding unbidden guests of long tongues.

I think the flower is specially adapted to small bees of the genus *Halictus*, which are of the right size to enter the tube. In Illinois in June, and in Florida in March, I have found it visited abundantly, both for honey and pollen, by *H. confusus* Sm. ♀. This bee crawls so far into the tube that it is entirely hidden from view.

The anthers and stigma are so closely approximated, that, in the absence of insects, it seems as if self-pollination may readily occur.

Veronica Virginica L.*—The white flowers are crowded in close spikes at the summit of the stalks, and are fertilized by insects crawling over them. They appear to be male at first, the anthers standing 7 mm. beyond the mouth of the tube, and becoming widely separated in the female stage. The corolla tubes measure 5 mm., and the nectar is sought by mid-length and long tongues.

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* On the genus, see Müller, "Fertilization of Flowers," 438 & 634.

I observed the following visitors on 8 days, between July 7 and August 11:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, s.; (2) Bombus vagans Sm. ☿, s.; (3) B. americanorum F. ☿, s.; (4) Melissodes bimaculata Lep. ♂, s.; (5) Ceratina dupla Say ♀, s. & c.p.; (6) Alcidamea producta Cr. ♀, s.; (7) Heriades carinatum Cr. ♀, c.p. *Andrenidæ*, (8) Agapostemon nigricornis F. ♂♀, s.;; (9) Augochlora pura Say ♂ ♀, s. & c.p.; (10) Halictus coriaceus Sm. ♀, c.p.; (11) H. confusus Sm. ♀, c.p. *Sphecidæ*, (12) Ammophila procera Klug; (13) Sphex ichneumonea L.

Lepidoptera.—*Rhopalocera*, (14) Pyrameis huntera F.; (15) Chrysophanus thoe Bd.-Lec.; (16) Lycæna comyntas Godt.; (17) Pieris rapæ L. *Pyralidæ*, (18) Scepsis fulvicollis Hübn.; (19) Nemophila noctuella V.; (20) Eurycreon rantalis Guén.—all s.

Diptera.—*Bombylidæ*, (21) Exoprosopa fasciata Macq., s. *Syrphidæ*, (22) Mesograpta geminata Say, f.p.; (23) Eristalis transversus Wied., f.p. *Tachinidæ*, (24) Jurinia apicifera Walk., s.

Hymenoptera.—*Lygæidæ*, (25) Lygæus turcicus F., s.

Scymeria macrophylla Nutt.— In the American Naturalist, xix. 72, this flower is described and figured by Foerste, and I have little to add to his description, except a list of visitors. The tube of the corolla is strongly compressed horizontally, so that the upper and lower walls are closely applied to each other. In the throat the corolla is strongly bearded, which serves to exclude small intruders, and enables the bees to hold on better when they are collecting pollen.

A bee with a proboscis 9 mm. long can reach the nectar from the outside, while short-tongued bees can reach it by squeezing into the throat. This cannot be accomplished with ease except by the larger and stronger bees.

The style is very short, so that there is nothing to prevent pollen from the anthers being carried back to the stigma.

The plants are scattered under the trees on whose roots they form parasitic attachments. The flowers are yellow, arranged in interrupted, leafy spikes, and are not very conspicuous.

The principal visitors are bumble-bees. On one occasion I counted 67 individuals at work on the flowers. On 6 days, between July 28 and Aug. 8, I observed the following visitors:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, s., one; (2) Bombus vagans Sm. ☿, s. & c.p., ab.; (3) B. americanorum F. ☿, s. & c.p., ab.; (4) B. ridingsii Cr. ☿, s. & c.p., one; (5) B. virginicus Oliv. ☿. s., one; (6) Melissodes bimaculata Lep. ♂, s., one.

Lepidoptera.—*Rhopalocera*. (7) Pieris rapæ L., s., one; (8) Pamphila zabulon Bd.-Lec., s., freq.

Diptera.—*Syrphidæ*. (9) Milesia ornata F., f.p., one.

*Gerardia pedicularia** L.—The flowers resemble those of *G. flava*, as shown on plate ii. of Goodale's "Wild Flowers." The upper wall of the corolla tube is straight, while the lower is concave within. The flowers are synacmic. The style, which lies against the upper wall, curves out over the mouth of the corolla. The stigma runs down each side, where it will easily touch a bee entering on either side. The stigma touches the bee far in advance of the anthers, and cannot receive pollen from them. The anther-cells are tipped below with long awns. The pollen is light and dry, and remains in the cells until a bee touches one of the points, when the chink of the anther gapes and a little pollen is sifted out. If the pressure is continued, all the pollen falls out. The pollen is in this way protected from small bees and flies, and is only discharged when a bee is in position to receive it. The hairs on the anthers and filaments are for the bees to cling to when sifting out the pollen.

The most abundant visitor, and the one for which the flower is most perfectly adapted, is ***Bombus americanorum***. This bee always turns head-downwards on entering the flower, and inserts its proboscis into the base of the tube for honey. When it enters the flower, or backs out, the basal joints of its legs strike the tips of the anther-cells, when the pollen falls out. I had often wondered why this bee turned up-side down to enter the flower, and at first supposed that it was because she wanted to collect pollen at the same time, and turned so as to dislodge it. But I discovered that the form of the flower requires it; for the male, which is almost as frequent a visitor as the females and workers, and only visits the flower for honey, always reverses, which it certainly would not do unless the form of the flower made it necessary. The modification which requires the bees to reverse is associated with the peculiar mode of pollen-discharge.

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* See Bailey, Torr. Bull. ii. 39, and Am. Nat. vii. 689. On *G. flava*, see Bailey, Am. Nat. xiii. 649, and Young, Torr. Bull. iv. 41.

Smaller bumble-bees, and some other bees which never or rarely try to suck, hang under the anthers and work out the pollen by striking the trigger-like awns. They reverse of their own accord, since they are so small they are not compelled to do so on account of the form of the flower. The tube is large and the narrow part only about 10 mm. long, so that most bumble-bee workers could easily reach the nectar if the tube were not curved in the opposite direction from that of most flowers, and if the anthers did not obstruct the entrance. On one occasion, I saw *Bombus separatus* ♂ alight in the mouth of the corolla, and, not knowing how to enter, fly away without obtaining any nectar. Prof. W. W. Bailey mentions that small bumble-bees, which he saw sucking at holes in the flower, were baffled when they attempted to go in at the mouth. If these bees made the holes at which they were sucking, it was no doubt because they did not know how to reach the nectar in the proper way.

Although the flower secretes nectar and is enabled to increase its set of visitors in this way, the chief attraction is the pollen. Early in the morning the bees are busy collecting the pollen, but as soon as it is gone they are less attentive, aud the flower soon withers.

The following visitors were observed on eight days, between Aug. 21 and Sept. 14:

Hymenoptera.—*Apidæ*, (1) Bombus virginicus Oliv., ☿, s. & c.p.; (2) B. separatus Cr. ☿, c.p.; (3) B. vagans Sm. ☿, s., once; (4) B. americanorum F. ♂ ♀ ☿, s. & c.p., ab; (5) Megachile mendica Cr. ♀, c.p.

Birds.—*Trochilidæ*, (6) Trochilus colubris L., once; front and base of bill white with pollen. It is interesting to note that, while the bees must alight and reverse to get the nectar, the humming-bird can obtain it while on the wing. *Halictus confusus* Sm. ♀ visits the flower for stray pollen.

Gerardia purpurea L.—The form of this flower resembles that of the preceding, but the flower is much smaller and of a handsome purple color. The upper wall of the corolla is straight, while the lower is curved and longer, so that, when the flower stands horizontally, the mouth looks upward and forward. As in *G. pedicularia*, this form of the corolla requires the bees to reverse to reach the nectar. On one occasion I saw a worker of

Bombus americanorum visiting flowers of this plant and of *G. auriculata* indiscriminately. On *G. auriculata* it entered in an upright position, but always turned up-side down to reach the nectar of *G. purpurea*. The style with its lateral stigmatic surfaces projects across the upper part of the mouth of the corolla, and bees enter on each side of it. The anther-cells are not awned as in *G. pedicularia*, but merely pointed, and the pollen is sifted out in a similar manner. Some smaller bees which do not attempt to reach the nectar, and are not required to reverse, do so in order to dislodge the pollen.

The flower is visited mainly for pollen. The fall of the flower has little reference to the secretion of nectar; I have seen *B. americanorum* visiting the flowers for nectar, and falling to the ground with nearly every flower it entered. The narrow part of the tube is about 5 mm. long.

On 6 days, between Sept. 6 and 26, I observed as visitors:

Apidæ, (1) Bombus americanorum F. ♂♀☿, s. & c.p., ab.; (2) B. virginicus Oliv. ☿. s. & c.p., one; (3) Melissodes perplexa Cr. ♀, c.p.; (4) Megachile brevis Say ♀, s. & c.p.

Lepidoptera.—*Rhopalocera*, (5) Pamphila sp., s., one.

Gerardia tenuifolia Vahl.—A good illustration of this flower is on plate ii. of Goodale's "Wild Flowers." It is short and broad, with purple lobes. The tube within is white and spotted with purple. The narrow part of the tube is so short that a proboscis 2 or 3 mm. long can reach to the bottom of it. In a general way the flower agrees with that of *G. purpurea*, but the tube is so short that bees are not compelled to reverse. Accordingly, when sucking they take an upright position, but when collecting pollen they hang to the hairy stamens and work out the loose pollen with their legs. The pollen is the chief source of attraction, and the flower, on account of its abundance, occupies an important place in the economy of bumble-bees as a pollen-flower. On account of the short tube, the flowers are sought by a greater number of species and more individuals of each than in the two preceding.

On ten days, between Aug. 26 and Sept. 12, I observed the following visitors:

Hymenoptera.—*Apidæ*, (1) Apis mellifica L. ☿, s. & c. p., ab.; (2) Bombus virginicus Oliv. ☿, s. & c.p., ab.; (3) B. separatus Cr. ☿, c.p.;

(4) B. americanorum F. ♀ ☿, s. & c.p., ab.; (5) B. scutellaris Cr. ☿, c.p.; (6) Melissodes perplexa Cr. ♀, c.p.; (7) Ceratina dupla Say ♀, s.; (8) Megachile brevis Say ♀, c.p.; (9) M. mendica Cr. ♀, c.p.; (10) Calliopsis andreniformis Sm. ♂ ♀, s. & c.p.

Lepidoptera.—*Rhopalocera*, (11) Pieris rapæ L.; (12) Colias philodice Godt.; (13) Pamphila sp.—all sucking, but mere intruders.

Halictus confusus Sm. ♀ collects stray pollen. *Syrphus americanus* Wied. and other *Syrphidæ* eat stray grains. *Pyrota mylabrina* Chev. (Meloidæ) gnaws the petals and anthers.

Gerardia auriculata Michx.— Resembles *G. tenuifolia*, but the corolla is somewhat larger and longer, and the style is not so far advanced in front of the anthers. The narrow part of the tube is about 4 mm.; but nectar seems to be of little importance, since the flower is visited almost exclusively for pollen. Like most pollen-flowers, it is visited early in the morning, and soon withers.

On Aug. 30 and Sept. 1st I observed as visitors—

Apidæ, (1) Bombus americanorum F. ☿, sucks in an upright position, but reverses to collect pollen; (2) B. pennsylvanicus DeG. ☿, s. one; (3) B. virginicus Oliv. ☿, s. & c.p.; (4) Melissodes perplexa Cr. ♀, c.p., reversing; (5) Megachile brevis Say ♀, s. & c.p., reversing.

Halictus confusus Sm. ♀ collects pollen which falls on the lower lip.

Under the head of "Tipo violaceo" Delpino* includes flowers which are so formed that their guests must turn up-side down in order to reach the sweets. As examples he mentions *Viola*, *Gratiola officinalis*, and *Epipogum Gmelini*. To this number must be added *Gratiola Virginiana*, *Gerardia pedicularia*, and probably its allies of the section *Dasystoma*, and *G. purpurea*. *Viola* (and probably *Epipogum Gmelini*) has no doubt become fitted to its visitors and then changed to an inverted position, so that the insects must invert also. These inverted flowers, therefore, retain their original relations to their pollinators; *Viola* still dusts them on the underside, and *Epipogum* fastens its pollinia on their uppersides. But the *Gratiolas* and the *Gerardias* originally applied their pollen to the insect's back, so that the form which compels the insect to reverse changes the flower from *nototribe* to *sternotribe*. The *Gerardias* have de-

---

* Ulteriori osservazioni.

veloped the habit of holding up their pollen until the points on the anthers have been touched by a bee. The bee, on the other hand, has acquired the habit of turning and hanging to the stamens in order to dislodge the pollen with its legs, and this habi is an advantage to the bee and to the flower also. *G. pedicularia* and *G. purpurea* have, therefore, acquired a form which requires even male bees, which do not come for pollen, to turn and enter the flowers so that they will be certain to strike the anther-points with their legs. Flowers of the "Tipo violacio" are apt to have some intruders which suck without turning, such as *Bombylius* on *Viola*, and the humming-bird on *G. pedicularia*.

Castilleia coccinea Spreng. — The flowers are subtended by broad, 3-cleft leaves, or bracts, which are bright scarlet at the summit, and form the most attractive part of the inflorescence. The calyx is laterally compressed, cleft in front and behind, and is scarlet at the tip. The pale corolla is also compressed and is included in the calyx. The lower lip is almost entirely aborted, being reduced to three small points. There is, therefore, nothing about the flower which can be considered as a landing-place for insects. The anthers are inclosed in the upper lip, which is long and narrow. The mouth of the corolla is closed. When a pencil-point is thrust into the throat, the upper lip opens and is thrown forward, so that the anthers are brought against the pencil. The style is exserted, holding the stigma over the mouth of the flower, and this also is thrown forward when anything separates the lateral edges of the mouth. The stigma strikes the visitor in advance of the anthers, and this secures cross-fertilization.

The scarlet color and the absence of a landing-place suggest that the flower is adapted to humming-birds, and the ruby-throat (*Trochilus colubris* L.) is the only visitor I have observed, although bumble-bees and butterflies may sometimes occur, since the tube is only about 15 mm. deep. The plant blooms about the time of arrival of *Trochilus* from the south. In 1886 the first humming-bird seen was on May 5, visiting the *Castilleia*.

Carlinville, Ill.

A Formula for Predicting the Population of the United States.

By H. S. Pritchett.

It is often desired to represent by a mathematical equation the law connecting a series of observations for which theory gives no explanation. In such a case ignorance of the physical cause of the phenomena observed does not diminish the accuracy of the computed formula for purposes of prediction, provided the observations are accurate and there are enough of them, and provided the same causes continue to operate.

As the forces giving rise to a series of phenomena become more complicated, the equation which would represent the law connecting the phenomena would generally be correspondingly complicated. When such observed quantities result from a few general causes modified by factors varying among themselves in magnitude and direction, it may be possible to represent the observations fairly well by a comparatively simple equation.

The problem of deriving an equation to represent the law of growth of population in the United States is such a case. The factors entering into this growth, such as birth-rate and death-rate, immigration and emigration, &c., are more numerous and fluctuating than in older and longer settled countries. Since, however, the only trustworthy means of predicting the population for the future consists in reasoning from the law of growth in the past, it has seemed to me an interesting question to see how nearly the data already at hand could be represented by a mathematical function.

The data available for this discussion, up to December 1890, are contained in the ten enumerations of the census from 1790 to 1880 inclusive. The results of these enumerations are given in the following table. The population there given is exclusive of the inhabitants of Alaska and of Indians on reservations.

Year.		Population.
1790	....	3,929,214
1800	....	5,308,483
1810	....	7,239,881
1820	....	9,633,822
1830	....	12,866,020
1840	....	17,069,453
1850	....	23,191,876
1860	....	31,443,321
1870	....	38,558,371
1880	....	50,155,783

A preliminary plat showed that these values could be approximately represented by a parabola, and would be closely represented by an equation of the form :—

$$P = A + B t + C t^2 + D t^3$$

where P represents the population and t the time from some assumed epoch.

Expressing the population in millions and fractions of a million, and the time (t) in decades (census years) counting from 1840, the observations furnish the following 10 equations of condition for determining the constants A, B, C and D :

$$
\begin{array}{lr}
 & v. \\
A - 5B + 25C - 125D - 3.929 = 0 & +0.078 \\
A - 4B + 16C - 64D - 5.308 = 0 & -0.038 \\
A - 3B + 9C - 27D - 7.240 = 0 & -0.176 \\
A - 2B + 4C - 8D - 9.634 = 0 & -0.060 \\
A - B + C - D - 12.866 = 0 & +0.119 \\
A - 17.069 = 0 & +0.411 \\
A + B + C + D - 23.192 = 0 & +0.052 \\
A + 2B + 4C + 8D - 31.443 = 0 & -0.982 \\
A + 3B + 9C + 27D - 38.558 = 0 & +0.758 \\
A + 4B + 16C + 64D - 50.156 = 0 & -0.163
\end{array}
$$

Solving by the method of least squares, there result the following normal equations:

$$
\begin{array}{l}
10A - 5B + 85C - 125D - 199.395 = 0 \\
-5A + 85B - 125C + 1333D - 307.645 = 0 \\
+85A - 125B + 1333C - 3125D - 1598.197 = 0 \\
-125A + 1333B - 3125C + 25405D - 3409.531 = 0
\end{array}
$$

From their solution we obtain the most probable values of A, B, C and D as follows:

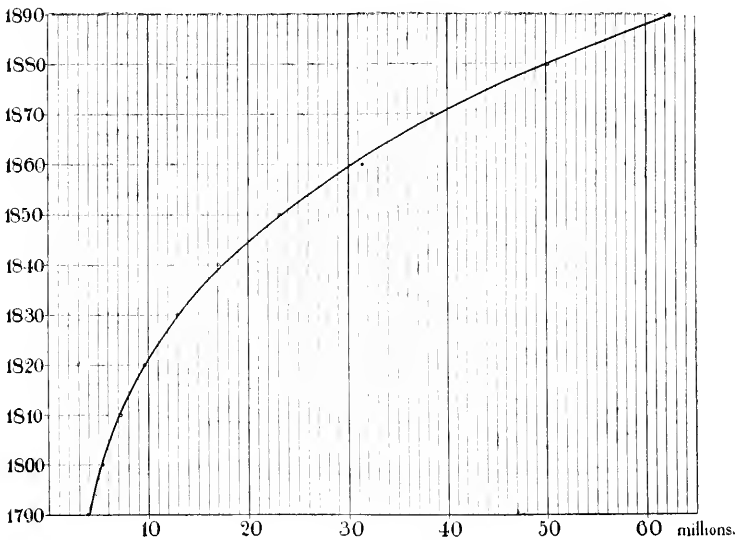
$$
\begin{array}{l}
A = +17.47969 \\
B = +5.09880 \\
C = +0.634506 \\
D = +0.0307275
\end{array}
$$

Accordingly, the population "P" for any time "t" would be represented by the equation:—

$$P = 17.47969 + 5.0988\,t + 0.634506\,t^2 + 0.0307275\,t^3 \quad - \quad - \quad (1)$$

This equation is evidently not what might be called a normal or natural population curve. It has no asymptotes and P becomes zero for a value of t equal to about -9.4, corresponding to the year 1746. For larger negative values of t, P becomes negative. This, however, is what is to be expected from the data used, since the population there given is not the result of a slow natural growth from an original small beginning, but is largely the result of accretions from outside.

How accurately this formula represents the observed values of the population will be seen from the graphical representation of the computed curve which follows. In this plat the axis of Y is the time axis, and the abscissas represent the population expressed in millions. The observed values of the population for each decade are represented by the black dots, and the black-line curve is furnished by formula (1). With the exception of the values for 1860 and 1870, it will be noted that the curve fits the observations with great exactness.



Substituting the values of A, B, C and D into the equations of condition, there result the residuals given in the column headed "v." An examination of these residuals brings out several interesting facts.

The smallness of the residuals, and the consequent close agreement of the formula with the observations, establishes the fact that the general growth of the population has been in the main a regular and orderly one.

There are two residuals which have abnormally large values. These occur in the equations furnished by the census of 1860 and the census of 1870. The census of 1860 shows a population 982,000 greater than the census value, while the census of 1870 falls 758,000 short of the computed value. The explanation of these discrepancies is to be found in the effects of the civil war upon the growth of population. The devastating effect of the war would show itself in the census of 1870 and succeeding years. This effect would be to give a value of the population in 1870 much below that which would be expected. This is precisely what we find to be the case, the census enumeration in that year falling 758,000 below the computed value. An abnormally small value in 1870 would, of course, have its effect upon the population of succeeding decades, and would give an apparent difference of opposite sign to the observed population in 1860. There is, however, good reason to believe that the value of the population as determined by the census in 1870 is much smaller than the population really was at that time, and there can be little question that the computed value is much nearer the truth than the census determination at that date. The present Superintendent of the Census, Mr. Robert P. Porter, makes the following statement concerning the census of 1870 (Census Bulletin No. 12, Oct. 30, 1890):

It is well known, the fact having been demonstrated by extensive and thorough investigation, that the census of 1870 was grossly deficient in the southern States, so much so as not only to give an exaggerated rate of increase of the population between 1870 and 1880 in these States, but to affect very materially the rate of increase in the country at large.

These omissions were not the fault nor were they within the control of the Census Office. The census of 1870 was taken under a law which the Superintendent, General Francis A. Walker, characterized as "clumsy, antiquated, and barbarous." The Census Office had no power over its enumerators save a barren protest, and this right was even questioned in some quarters. In referring to these omissions the Superintendent of the Tenth Census said in his report in relation to the taking of the census in South Carolina: "It follows as a conclusion of the highest authority, either that the census of 1870 was grossly defective in regard to the whole of the State or some considerable parts thereof, or else that the census of 1880 was fraudulent." Those, therefore, who believe in the accuracy and honesty of the Tenth Census — and that was thoroughly established—must accept the other alternative offered by General Walker, namely, that the Ninth Census was "grossly defective." What was true of South Carolina was also true, in greater or less degree, of all the southern States.

There is, of course, no means of ascertaining accurately the extent of these omissions, but in all probability they amounted to not less than 1,500,000. There is but little question that the population of the United States in 1870 was at least 40,000,000, instead of 38,558,371, as stated.

The computed value just given is 39,316,000; but this is, of course, affected to a certain extent by the error in the census of 1870, which entered into the computation of formula (1). To compute a value for 1870 which shall be derived from data unaffected by the deficit due to the war, it will be necessary to discuss the observations from 1790 to 1860 alone. The data furnish the following 8 equations of condition:

$$\begin{array}{lr|r}
 & & v. \\
A - 5B + 25C - 125D - 3.929 & = 0 & -0.083 \\
A - 4B + 16C - 64D - 5.308 & = 0 & +0.166 \\
A - 3B + 9C - 27D - 7.240 & = 0 & +0.010 \\
A - 2B + 4C - 8D - 9.634 & = 0 & -0.090 \\
A - B + C - D - 12.866 & = 0 & -0.136 \\
A - 17.069 & = 0 & +0.112 \\
A + B + C + D - 23.192 & = 0 & +0.083 \\
A + 2B + 4C + 8D - 31.443 & = 0 & -0.061
\end{array}$$

Solving by the method of least squares for the value of A, B, C and D we obtain the following function:—

$$P = 17.1819 + 5.210279\,t + 0.8201904\,t^2 + 0.0623182\,t^3 \quad - \quad - \quad (2)$$

How closely this equation fits the observed values will be seen from the table of residuals. These residuals show that during the 70 years from 1790 to 1860 the growth of population followed the law expressed by equation (2) very accurately, and also that this rate of growth was more rapid than that of later decades. Had this rate of growth continued to 1870, the population would have amounted at that time to 41,877,100. The diminution during the decade due to those actually killed, to lessened immigration and decreased birth-rate, cannot be stated with exactness, but probably approximates 1,700.000. After deducting this loss it does not seem possible that the population in 1870 could have been less than 40,000,000, a result entirely in accordance with the conclusions arrived at by the last two Superintendents of the Census.

Had the population continued to grow after 1860 at the same rate as before, we should have had in 1890 a population of over 71 millions, about nine millions more than we really have. It is scarcely possible that the whole of this difference is chargeable to the war, but is probably due in part to a diminishing birth-rate.

PROBABLE ERROR.

Assuming the formula correct, there results for the probable error of a single determination of the population ± 0.367, expressed as a fraction of a million.

This error contains, of course, both the error of the formula and the error of the census enumeration. Assuming A, B, C and D as independent quantities, we obtain for their probable errors the following values:

Probable error of A $= \pm$ 0.179
Probable error of B $= \pm$ 0.127
Probable error of C $= \pm$ 0.0178
Probable error of D $= \pm$ 0.0066

From these values, expressing P as a function of A, B, C and D its probable error may be computed at any time. This probable error would remain a small percent of the computed population.

VALUE OF THE FORMULA FOR PREDICTION.

How closely formula (1) will continue to represent the growth of population during future decades depends, of course, upon the continuance of the same conditions of growth. A decided change in the birth-rate, or rate of immigration, or a destructive war, would bring out a large discrepancy between the computed and observed values. A fair test of the formula is found by computing the population for 1890. According to the formula we should expect in 1890 a population of 62,677,280. The Census Bureau has within the last few weeks finished its count of the population in 1890, obtaining the result 62,622,280. The agreement between these two results is all that could be desired, the difference of 55,000 being within the limit of error of both the formula and the census count.

The general law governing the increase of population, as usually stated, is that, when not disturbed by extraneous causes, such as wars, pestilences, immigration, emigration, &c., the increase of population goes on at a constantly diminishing rate. By this it is meant that the percentage of increase from decade to decade diminishes. The law of growth expressed by equation (1) involves such a decrease in the percentage of growth.

Differentiating equation (1) we have

$$\frac{\frac{P}{dt}}{P} = \frac{B + 2\,Ct + 3\,Dt^2}{A + Bt + Ct^2 + Dt^3}$$

which diminishes as t increases, and approaches zero as t approaches infinity. In 1790 the percentage of increase per decade was 32 per cent.; in 1880 24 per cent.; in 1990 will be 13 per cent., and in 1.000 years will have sunk to a little less than 3 per cent.

In order to include all available data, I have re-solved for A

B, C and D including the data of 1890. This would yield the following 11 equations of condition :—

	v.
$A - 5B + 25C - 125D - 3.9292 = 0$	$+0.083$
$A - 4B + 16C - 64D - 5.3085 = 0$	-0.041
$A - 3B + 9C - 27D - 7.2399 = 0$	-0.181
$A - 2B + 4C - 8D - 9.6338 = 0$	-0.065
$A - B + C - D - 12.8660 = 0$	$+0.119$
$A - 17.0695 = 0$	$+0.415$
$A + B + C + D - 23.1919 = 0$	$+0.058$
$A + 2B + 4C + 8D - 31.4433 = 0$	-0.975
$A + 3B + 9C + 27D - 38.5584 = 0$	$+0.754$
$A + 4B + 16C + 64D - 50.1558 = 0$	-0.181
$A + 5B + 25C + 125D - 62.6222 = 0$	$+0.012$

These yield the following normal equations :—

$$+11.0A + 0.0B + 110.0C + 0.0D - 262.017 = 0$$
$$0.0A + 110.0B + 0.0C + 1958.0D - 620.753 = 0$$
$$+110.0A + 0.0B + 1958.0C + 0.0D - 3163.765 = 0$$
$$0.0A + 1958.0B + 0.0C + 41030.0D - 11237.254 = 0$$

From which result the following values of A, B, C and D :—

$A = 17.4841 \quad B = 5.1019363 \quad C = +0.6335606 \quad D = +0.0304086$

and the population (P) at any decade (t) after 1840 will be given by the equation,

$$P = 17.4841 + 5.1019363t + 0.6335606t^2 + 0.0304086t^3 \quad \cdot \quad (3)$$

This formula, being the most probable result deducible from all the data, forms the best basis at hand for predicting the population of the future. In the course of time it is to be expected that this will depart more and more from the observed values, but for the next hundred years will doubtless represent the growth of population within a small percentage of error. Carrying forward the computation, we obtain to the nearest thousand the following values for subsequent dates :

Year.	Computed Population.
1900	77.472,000
1910	94,673.000
1920	114.416,000
1930	136,887,000
1940	162.268,000
1950	190,740.000
1960	222.067,000
1970	257,688.000
1980	296,814.000
1990	339.193.000
2000	385.860.000
2100	1.112.867,000
2500	11,856.302,000
2900	40,852,273,000

These figures are suggestive, to say the least. They show that within a hundred years the population of this country will amount to 350 millions; and within a thousand years, if the present rate of growth continues, this number will have swelled to nearly 41 billions.

How great a change in the conditions of living this growth of population would imply it is, perhaps, impossible for us to realize. Great Britain, at present one of the most densely populated countries of the globe, contains about 300 inhabitants to the square mile. Should the present rate of growth continue until the year 2900, the United States would contain over 11,000 persons to each square mile of surface.

With growth of population our civilization is becoming more and more complex, and the drafts upon the stored energy of the earth more enormous. As a consequence of all this, it would seem that life in the future must be subject to a constantly increasing stress, which will bring to the attention of individuals and nations economic questions which at our time seem very remote.

H. S. PRITCHETT.

December, 1890.

Observations of the Transit of Mercury, May 9, 1891.

By H. S. Pritchett.

The observations of the Transit of Mercury, which are described below, were made with the 6½ in. Equatorial of the Observatory of Washington University. A magnifying power of 140 was used, and the shade glass employed was a combination of green and red which gave a soft dirty white tint to the sun's disc.

The atmospheric conditions on the afternoon of the 9th were unusually good, and, although the sun was only 10° high when the transit began, the images were steady and distinct. Contacts were observed as follows in Greenwich mean time. The filar micrometer was used, and, having been set to the computed position angle, it was easy to cut off a small segment of the sun's disc within which the planet was to be expected.

Phase	May 9, '91. Gr. M. T.	REMARKS.
	h. m. s.	
A.	11 53 14.6	The time given marks the first moment when I could detect a suspicious movement at the point of the sun's limb where the planet was to enter. The encroaching disc of the planet could not be made out as an indentation until some seconds later. My impression at the time was that I had observed the earliest possible moment when the planet could be seen.
B.	11 55 17.4	At this instant the small disc of the planet was estimated to be exactly bisected by the sun's limb. This phase can be noted with great sharpness. The time given above cannot be in error, I think. by more than 5 seconds.
C.	11 57 29.6	The planet appeared to be in geometric contact with the sun's limb.
D.	11 57 49.0	The light first flashes around the disc of the planet. This is probably the moment of true internal contact.

With regard to these observed phases, it is to be remarked that phase A, as already indicated, was the first moment when I could detect motion at the sun's edge. Using the micrometer wire to mark the place of entrance, I was watching the sun's limb at the exact point where the planet entered. The image was steady, and I noticed no distortion or unusual phenomena as the planet entered upon the sun's disc. I am led to think, for reasons given later, that this phase for external contact corresponds to phase C for internal contact.

Phase B, when the planet's disc was just bisected by the sun's limb, is capable of very exact observation. It can be noted quite as accurately, and I am inclined to think more accurately, than the contacts of the limbs, and its observation is free of many of the personal elements of uncertainty that enter into observations of the contacts. I am of the opinion that more accurate and uniform results can be obtained from the observation of this phase than from the contact observations.

Phase C was noted at the moment when the limb of the planet seemed to have come into geometrical tangency with the sun's limb. The two discs did not separate, however, until some seconds later, although I noticed no distortion.

Phase D marks the first moment when the thread of sunlight seemed to flash around the limb of the planet, and corresponds, no doubt, to the moment of true internal contact.

During the interval between the external and internal contacts, and afterward when the planet was fully projected on the sun's disc, it was studied carefully to see if any trace of an atmospheric ring, or any variations in the color of the disc, could be seen. Nothing of this nature could be detected either by myself or by several others who looked at the planet. The planet presented the appearance of a uniformly black disc projected upon the disc of the sun.

The effects of irradiation in observations of this character, and the discrepancies between the observations of different observers caused thereby, have given rise to much discussion in connection with recent observations of the transits of Mercury and Venus. During the transit which has just occurred my observations were directed specially toward a study of the amount and character of the irradiation effects upon the contact observations.

For this reason I noted with as great care as possible all the phases of the contact observations, and also the moment when the sun's limb appeared to bisect the disc of the planet. This last phase should be free of the effect of irradiation. and a comparison of it with the contact observations should give some idea of the effect of the irradiation upon the contact observations.

The effect of irradiation would be to diminish the apparent disc of the planet as seen in projection on the sun's limb. In consequence the observed external contact of this disc with the sun's limb would come later and the internal contact earlier than those of the real image of the planet as unaffected by irradiation.

Referring now to the observations of phases A and C, there can be no question, I think, that they refer to the external and internal contacts of the planet's disc as affected by irradiation. The mean of the two times is 11*h*. 55*m*. 22*s*., which agrees closely with the observed time of that phase.

Between observations C and D there was no apparent distortion of the planet's disc, but the planet seemed to cling to the edge of the sun. The observation noted D is the instant when the light first flashed between the limb of the sun and the planet. Assuming this to be the moment of true internal contact, the 19.4 seconds between C and D would measure the effect of irradiation upon the contact time. This would correspond to a diminution of the planet's semi-diameter of 0″.81.

After the planet had entered fully upon the sun's disc, its diameter was measured with the filar micrometer. with the following results:—

For position angle	0°	diameter	= 10″.08
For position angle	90°	"	= 9 .83

These have been corrected for the differential refraction. The mean of these results would give for the apparent semi-diameter 4″.98. The angular semi-diameter in use both in the Berlin Jahrbuch and the American Ephemeris is that of Bessel, determined with the heliometer, and therefore free of irradiation. In A. N., No. 3034, Mr. L. Ambronn gives the result of all the best known determinations of the diameter of Mercury, both those obtained from double-micrometer methods and those resulting from measurements with filar micrometers. The result from all double-micrometer observations will differ but little from that of Bessel. At the time of transit the angular semi-diameter, according to Bessel, was 6″.02, which, compared with the measured semi-diameter, would indicate a diminution of the apparent semi-diameter of 1″.04 on account of the irradiation, a result quite fairly in accord with the preceding.

The irradiation effect would undoubtedly vary with the observer and telescope, and probably with the tint of shade-glass employed.

The result of this discussion would seem to show:—

1. That the discrepancies in different observations is due to actual differences in the apparent disc of the planet, due to irradiation. That the phases of geometric contact and actual separation of the discs are distinct and separate phenomena.
2. That the observation of the moment of bisection of the planet's disc is free from this effect.

In this connection, it may not be out of place to call attention to the fact that the values of the angular diameters of the planets Venus, Mars, Jupiter, Saturn, and Uranus, now in use in the computations of the American Ephemeris, are derived from the mural circle observations made at Washington in 1845–46. This instrument is small, and, when it is remembered that the observations were not made for the purpose of determining diameters, but for determinations of declination, it is not surprising that they should differ considerably from more modern observations.

The following comparison between the values used in the American Ephemeris, and those of the Berlin Jahrbuch, shows that there is a systematic difference in the assumed diameters of the bright planets Mars, Jupiter, and Saturn. I have reduced both values to the average distance of the planet from the Earth at opposition.

Planet.	Log. Dist.	Ang. Diameter, Ber. Jahr.	Ang. Diameter, Am. Ephm.	B.J.—A.E.
Mars	0.25	5″.26	5″.70	—0″.44
Jupiter (Polar)	0.70	36 .94	37 .56	—0 .62
Jupiter (Eq.)	0.70	39 .82	40 .00	—0 .18
Saturn (Polar)	0.95	16 .48	17 .54	—1 .06
Saturn (Eq.)	0.95	18 .26	18 .76	—0 .50

As the values used in the Berlin Jahrbuch depend upon measurements with double-image micrometers, it is to be expected that they should be smaller than those derived from the filar micrometer measures. But the magnitude of the differences shows that the values in use in the American Ephemeris at present must be considerably in error, and, while it may be preferable to retain in the Ephemeris values dependent on filar micrometer measurements, there is needed a new set of determinations dependent on recent measurements with an equatorial of moderate size and good definitim.

Mr. O. B. Wheeler, of the Missouri River Commission, has been kind enough to communicate the result of his observations, which are given herewith.

OBSERVATIONS BY MR. O. B. WHEELER.

Observer, O. B. WHEELER; *Recorder*, G. A. MARR.

Observations of the Transit af Mercury, May 9, 1891.

Station—Government Geodetic Point. "Water Tower," ST. LOUIS, MO.

Latitude, 38° 40′ 12″; Longitude, 90° 12′ 32″.
Height of station above ground, 160 feet.

Instruments.—Telescope a new refractor of three inches clear aperture, marked A. S. Aloe & Co., and generously loaned by this firm; mounting, altitude, and azimuth; magnifying power used, 110. Chronometer (mean time), John Hutton, No. 353.

Atmospheric Canditions.—Sky perfectly clear, except somewhat smoky near the horizon; atmosphere steady; a strong wind from the south, and station not protected from it.

		h. m. s.	
The Results.—	1st contact (Greenw. M.T.)	11 54 05.3	(strong indenture).
	2d " " "	11 57 22.9	(geometric contact).
	2d " " "	11 57 44.2	(true contact).

The Observations.—

	h. m. s.	
1st contact,	5 52 47.5	(strong indenture when first seen).
2d "	5 56 05.0	(geometrical contact, estimated).
2d "	5 56 26.3	(light breaks across).

Only one "tick" was given for each observation, and the times are as noted by the recorder from the face of the chronometer.

Comparison of Chronometer.—

		Howard Clock.	Chronometer.
			h. m. s.
(1)	Automatic 90th merid. hour-signal at 3 p.m., May 9,		= 2 58 41.0
(2)	Howard Clock (at Observy of Wash. Univ.)	8 26 00.0	= 8 24 41.3
(3)	" " " " "	22 24 00.0	= 22 22 40.8

Clock is fast 0s.6 and automatic apparatus closes at 59s.0. so there is a correction for (1) of —1s.6, and for (2) and (3) of —0s.6, to reduce Howard Clock to standard central time. Or:—

	h. m. s.		h. m. s.			m. s.
(1)	2 59 58.4	=	2 58 41.0	Chronometer slow	=	1 17.4
(2)	8 25 59.4	=	8 24 41.3	" "	=	1 18.1
(3)	22 23 59.4	=	22 22 40.8	" "	=	1 18.6

Hence, rate of chronometer is approximately 0s.1, losing per hour and the correction for 1st contact

	m. s.
and the correction for 1st contact	= + 1 17.8
" " " 2d "	= + 1 17.9

O. B. Wheeler, U. S. Ass't Eng'r, *Observer.*
G. A. Marr, " " " *Recorder.*

Notes on Palæozoic Crustaceæ, No. 1.

On some new Sedalia Trilobites.

By A. W. Vogdes.

The large and extensive family of trilobites, which consisted of eighty-one genera in the American Palæozoic age, is only represented in the Carboniferous by seven families. Of these the genera *Proctus*, *Cyphaspis*, *Dalmanites*(?) and *Phæthonides* are Devonian fossils, which reappear in the Lower Carboniferous limestones. The genera *Phillipsia*, *Griffithides* and *Brachymetopus* are typical fossils of the Carboniferous. These genera range as follows: *Phillipsia* from the Waverly series up into the Permian, *Griffithides* extends from the Keokuk to the Coal Measures. The last genus is very rare, but a persistent genus of the Lower Carboniferous appearing in the English, Irish, Russian, Australian and American groups. In England, Russia and Australia only one species appears. The Irish carboniferous rocks contain four species, and the American the following species: *Brachymetopus Lodiensis*, Meek, *B. immaturus*, Herrick, from the Waverly of Ohio. From Sedalia we have the new species described in this paper, making in all only eight species.

The fossil Crustacea of the Sedalia limestones have a strong Devonian facies, being represented by the genera *Proetus* and *Cyphaspis;* in fact such was the classification given by Swallow to the Chouteau group, Missouri Geol. Rep. 1855, p. 101; and to the Chemung by Prof. James Hall, Geol. Iowa, 1858, p. 103. They were referred to the Kinderhook by Worthen, Geol. Illinois, vol. 1, p. 109, in 1866. Since these investigations, Mr. F. A. Sampson of Sedalia has described in the Trans. N.Y. Acad. Sci. vol. 7, 1888, p. 247, the pygidium of a *Proetus* with 9 axial rings and 7 pleuræ, the axis being marked with 3 rows of nodes; his collection also contained a glabella which unquestionably belongs to the genus *Cyphaspis*. Dr. White also called attention to the Devonian facies of the Sedalia corals in the 12th Annual Report Geol. Survey of Territories, p. 159.

During our present studies of a series of Sedalia trilobites from Mr. F. A. Sampson's cabinet, we have compared them with foreign and American species. Among these fossils there are several specimens of *Phillipsia Sampsoni* which in general form approach a species from the Rhinish Devonian described by the Landbergh Bros., Rheinischen Scht. Syst., p. 30, pl. 3, fig. 3, as *Trigonaspis lævigata*, Goldf. This species has a similar pygidium to that of *Phillipsia Sampsoni* from Sedalia; but its glabella has a more decided proetoid form; it has also 10 segments in the thorax. The figure given of *Phillipsia Sampsoni* in the Trans. N. Y. Acad. Sci. vol. 7, p. 249, represents the glabella of this species tapering too rapidly to the front; its sides are parallel and conform more closely to the type of the genus.

These early species of Carboniferous Proetidæ are only confined to the American rocks. The only Devonian genus extending up into English carboniferous rocks is a species of *Cyphaspis* found at Yorkshire, lately described in the Quart. Journ. Geol. Soc., vol. 46, 1890, p. 421.

Although the Chouteau limestones have long been known and studied, it is a matter of considerable doubt as to the exact horizon to which they properly belong. The fossil crustaceæ and corals point to the Devonian; we hope our friends in Sedalia will clear up its classifications by extensive and systematic collections of the organic remains.

Amongst the American Carboniferous trilobites there are several genera with ornamented and fimbricated pygidia. These fossils have been classed under the genera *Phæthonides* and *Dalmanites* (?). The first genus was described by Barrande in 1846 under the name of *Phæton*, the author including under it both proetoid and fimbricated pygidia. This term being preoccupied in Natural History, Corda in 1847 proposed for such species of the *Proetidæ* the name of *Prinopeltis*. Barrande placed all the species described in his earlier work under *Proetus* in the Syst. Sil. Bohême, vol. 1, 1852. Angelin in 1854 revived the old name of *Phæton*, changing it into *Phæthonides;* this author follows Barrande and includes *Asaphus Stokesii*, Murch., under the genus. The amended genus has been used in the Palæontology of New York, vol. 7, 1888, and also in the Bulletin of the Denison University, vol. 4, 1888. Herrick describes four species under this term, referring doubtless to the following species: *Phætho-nides*(?) *immaturus*, Herrick, and *P.*(?) *Lodiensis*, Meek. The last species has been described both by English and American authors under *Brachymetopus.*

Under the law of priority Corda's genus should be used for this section of *Proetus* and *Forbesia*, McCoy, for such species as *Asaphus Stokesii*, Murch., which McCoy included under *Forbesia.*

The fimbricated pygidium alone is not worthy of generic classification, although a valuable guide in the identification of species. Both plane and spinous pygidia are common in the genera *Agnostus*, *Bronteus*, *Dalmanites*, *Olenus*, *Paradoxides*, and *Proetus;* and we may extend this characteristic to the genus *Brachymetopus* by including the new species described in this paper. *Griffithides Sedaliensis* probably belongs to the same genus.

In *Brachymetopus armatus* the posterior pleuræ of the pygidium are prolonged into spines; a more characteristic and extended congeneric species of this type is one described from the Cuyahoga shales of Ohio under the name of *Dalmamites*(?) *Cuyahogæ*, by Prof. Claypole. In this species all the pleura of the pygidium are extended beyond the border into spines.

Brachymetopus, McCoy.

Brachymetopus armatus, Vogdes.

Plate xv., figs. 4 and 5.

DESCRIPTION.

This new species is described from two fragments of the free cheeks and six pygidia. The free cheeks are triangular in form, bordered with an elevated ridge of equal width, the limb being produced in rear into moderate spines. The interior parts of the cheeks, between the eye and limb, slope gently, forming a depressed area emarginating the limb. Palpebral lobes large, eyes prominent and located about the centre of the head, near the glabella. The surface of the cheek is marked with a row of six tubercles, located about midway on them and running parallel to the border.

Pygidium parabolic in form. Axis prominent, tapering gradually to the rear into a blunt termination, not extended to the border, marked with eleven rings, and with five rows of nodes, a central and two lateral rows. The sides are marked with six ribs, separated from each other by broad grooves. The ribs are elevated ridges marked with a central row of nodes, varying from four to two, according to their length. The limb is indicated by a depression, the ribs extending on the limb and terminating with a node. The two posterior ribs are prolonged into spines, which extend over the border.

Affinities.—This species approaches *Brachymetopus Lodiensis*, Meek, from the Waverly group of Ohio; it can be readily distinguished from it, and from all other species of this genus, by its characteristic pygidium.

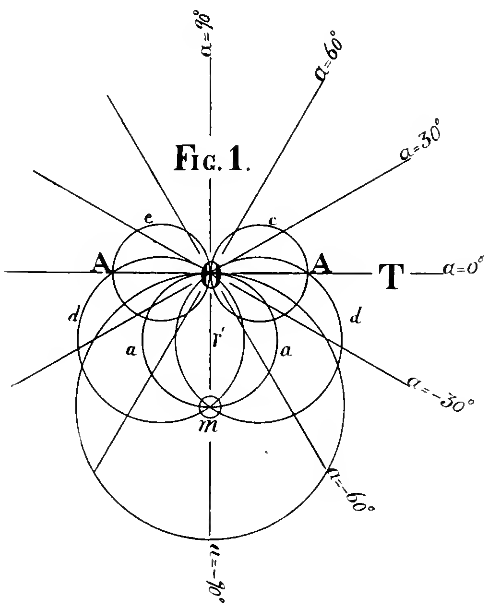
Geological position and locality.—Waverly Group, Sedalia, Missouri; from the cabinet of F. A. Sampson, Sedalia, Mo.

On Certain Properties of a Field of Force Due to a Single Mass.

BY FRANCIS E. NIPHER.

Let m (Fig. 1) represent the acting mass. At any distance r' along any radius, the force will be $m r'^{-2}$. At the point O draw any line at right angles to the radius mr', and let r represent the distance from m to any point on the line. The line drawn at right angles to the radial line will be tangent to a circle whose centre is m and whose radius is r'. For brevity we shall call this line OT the tangent line.

FIG. 1.



The force at any point on the tangent line resolved along that line will be

$$F' = \frac{m\, T}{(r'^2 + T^2)^{\frac{3}{2}}} \quad \text{- - - - - - -} \quad (1)$$

where T is the distance of the point from the point of tangency.

The value of F' may be laid off at right angles to the plane m, O, T, and will be represented by a curve like F' in Fig. 2. The properties of the field are symmetrical around the radial line r', so that tangent lines through the point O, at right angles to each other, would have the same values of F' at similar positions.

The force along the radial line would vary according to the equation

$$F = \frac{m}{r^2} \quad \text{- - - - - - - - - -} \quad (2)$$

and may be represented by the curve F in Fig. 2.

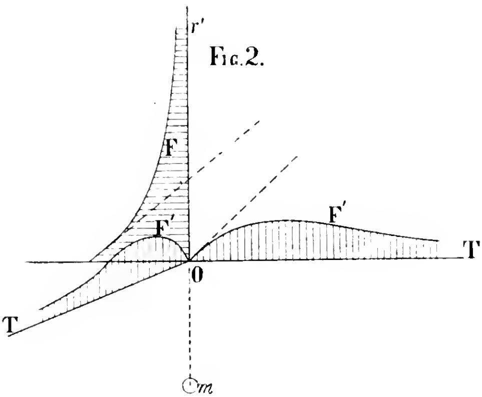


FIG. 2.

Laplace's equation

$$\left\{\frac{dF}{dr}\right\}_{r=r'} + \left\{\frac{dF'}{dT}\right\}_{T=o} + \left\{\frac{dF'}{dT}\right\}_{T=o} = o$$

means simply that the algebraic sum of the slopes of the three curves at the point O is zero.

If instead of resolving the force along the tangent line, it be resolved along any line cutting the tangent line in O and making with it an angle α, the component of F along this line becomes

$$F' = \frac{m(r' \sin \alpha + T)}{(r'^2 + 2r'T \sin \alpha + T^2)^{\frac{3}{2}}} \quad - - - (3)$$

The value of $F' = o$ when

$$T = - r' \sin \alpha,$$

the locus of which is a circle having the line r' as a diameter. This circle is marked *a a* in Fig. 1. F' also has a maximum and a minimum value when

$$T = - r' \sin \alpha \pm \frac{r' \cos \alpha}{\sqrt{2}} \quad - - - - - (4)$$

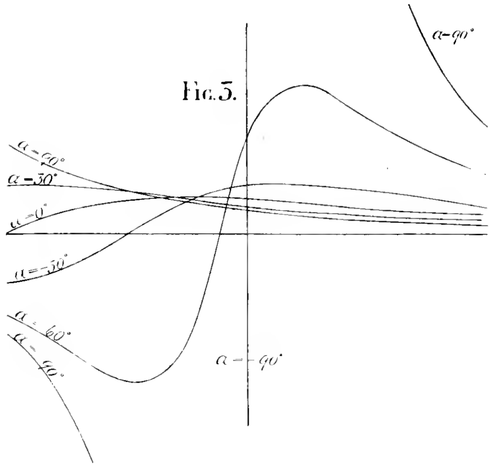
The final term in this equation represents two circles tangent to each other at the point O, having $\frac{r'}{\sqrt{2}}$ as horizontal diameters, measured outwardly along the tangent line. They are marked *c c* in Fig. 1. The value T in (4) represents two circles having radii $= r' \sqrt{\tfrac{3}{8}}$, which intersect each other in m and O, and which cut the tangent line in $\pm \frac{r'}{\sqrt{2}}$ respectively. They are marked *d d* in Fig. 1. These latter points represent the locus of maximum and minimum F' along the tangent line. Lines from these points through m pass through the centres of the two circles of maximum, and make with the line r' angles whose tangent is $\frac{1}{\sqrt{2}}$, whatever may be the length of r'.

The values of F' are graphically shown in Fig. 3 for a few values of α. The areas of all these curves from $T = o$ to $T = \infty$, or

$$A = \int_0^\infty F' d T$$

is the same and is $\frac{m}{r'}$, or the potential at O.

If the values F' be laid off at right angles to the plane of Fig. 1, each curve being plotted on the line determined by the angle α, the points determining the maximum and minimum F' will



lie on the surfaces of two cylinders whose traces upon the plane m, r, T are the two circles dd of Fig. 1. When $\alpha = o$, the maximum and minimum points are at A and A', the values of F' being

$$F'_{m'} = \pm \frac{m}{r'^2} \frac{2}{3} \sqrt{\frac{1}{3}}$$

If r be the perpendicular from m to any other line determined by the angle α so that

$$r = r' \cos \alpha ,$$

the maximum F' along this line will be similarly

$$F'_m = \pm \frac{m}{r^2} \frac{2}{3} \sqrt{\frac{1}{3}}$$

Hence,

$$\frac{F'_m}{F'_{m'}} = \frac{r'^2}{r^2} = \frac{1}{\cos^2 \alpha} .$$

The points representing the maximum and minimum F' will therefore lie in a kind of spiral around the two cylinders. If we suppose α to vary from o to + 90, the maximum will move through the arc $A\ O\ m$, varying in value from $F'_{m'}$ to ∞ .

The minimum will move from A' to m, varying in value from $-F'_{m'}$ to $-\infty$. Similarly a change in a from 0° to $-90°$ we shall have symmetrical changes through the other semicircles, A, d, m.

These spirals each project on the diametral planes $A\ m$ and $A'\ m$ of the cylinders as branches of equilateral hyperbolæ the asymptotes of which are the lines $A\ m$ and $A'\ m$, and the vertical line through m. The opposite branches of the hyperbolæ would also correspond to the case where m is negative.

If x be an abscissa of one of these hyperbolæ, measured from A as an origin, and k the angle $O\ m\ A$, then the equation of a right projection on the diametral plane is

$$F'_m = \frac{r'\ F'_{m'}}{r' - \sqrt{2}\ \sin\ k\ x}$$

The spirals project on a plane at right angles to $A\ m$ in a fourth degree curve somewhat resembling a section of a Florence flask with an infinitely long, pointed neck. The equation of this curve is

$$y^2 = \frac{r'^2}{2\ \sin^2 k}\left\{\frac{F'_{m'}}{F'_m} - \left[\frac{F'_{m'}}{F'_m}\right]^2\right\}$$

where y is the projection ordinate corresponding to x in the previous equation. The maximum ordinate y of this curve is found to correspond to a value $F'_m = 2\ F'_{m'}$, showing that the values F'_m at points 90° from $A\ A'$ around the cylinders are twice the values at A and A'.

EXPLANATION OF PLATE XV.

Figs. 1. 2, 3.

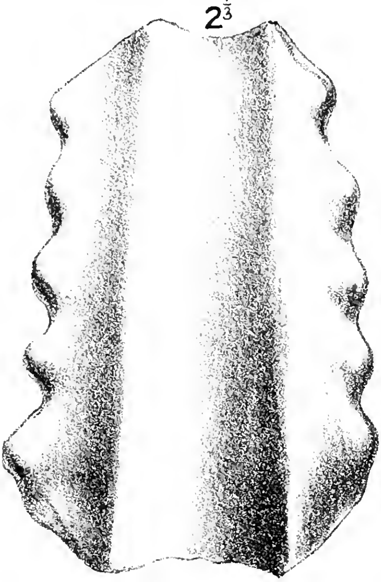
Straparollus magnificus, Shumard.

The type specimen here figured is in the collection of Dr. A. Litton of St. Louis, and was sent to him from Tennessee by his brother, who obtained it from a person who stated that it was found in Kentucky; but Dr. Shumard believes that it belongs to some one of the divisions of the Carboniferous System. It was first described by Dr. Shumard in the Transactions of the Academy of Science of St. Louis, vol. ii., p. 110, but not figured.

Fig. 4, *Brachymetopus armatus*. Vogdes, nat. size.

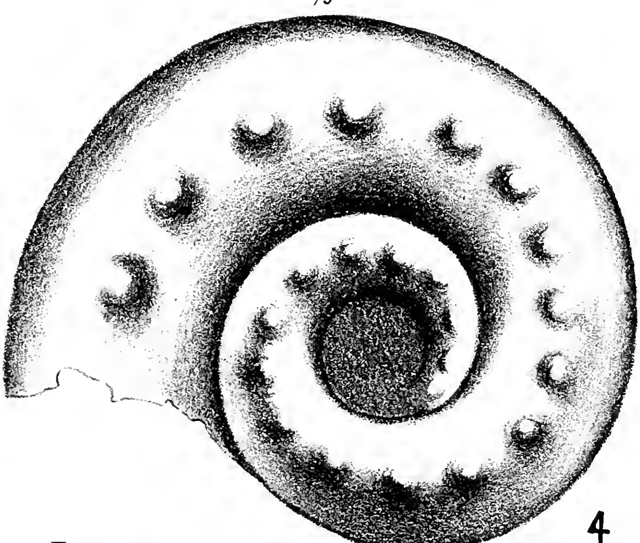
" 5, the same. *pygidium* enlarged 2½ times.

2 1/3

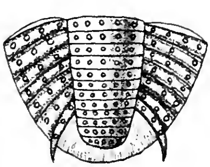


3 1/3

1 1/3

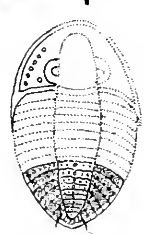


5



Enlarged 2¼ times.

4



Nat. Size.

GENERAL INDEX.

PROCEEDINGS.

April 5th, 1886.

President Nipher in the chair; fourteen members present.

Dr. Todd remarked, that, in dissecting the body of a negro, he had found a muscle in the fore-arm which had been thought to be extinct in the human species and something to indicate a reversion of type, illustrating his remarks by means of preparations made from a monkey.

Mr. Tivy exhibited specimens of real and bogus butter, and showed how it was possible to distinguish between them in the microscope, by the difference in the forms of their crystallization.

April 19th, 1886.

President Nipher in the chair; eleven members present.

Prof. Pritchett made some remarks concerning a comet, recently discovered by Mr. Barnard, of Nashville, and another discovered by Mr. Fabry, of Paris, now visible in the telescope, and suggested the possibility of their being the second appearances of the comets of 1784 and 1785, which idea was suggested to him by the similarity of the elements of their orbits. Mr. Pritchett also remarked that in observing, recently, one of the satellites of Jupiter, when projected against the planet's disk, he was particularly impressed with the variation in the brightness of the satellite's disk, appearing at times as a dark spot upon the surface of the planet and then changing so as to be quite invisible. As it was commonly supposed by astronomers that this change of brightness was due to the difference in the phases in the satellites, Prof. Pritchett thought it would be possible to determine from these changes the time of the satellite's rotation.

May 3d, 1886.

President Nipher in the chair: nine members present.

Dr. Wellington Adams made some remarks on the distribution of power by electricity, pointing out the difficulties to be overcome, and explaining the differences between the multiple and series systems. He also exhibited a machine which he had designed, constructed so as to automatically adjust the current used to the work required of it, and thus avoid a waste of power.

Prof. Nipher followed with calculations based upon conditions existing in the proposed elevated railroad in St. Louis, of the economical section of the conductor to be employed, when expense due both to loss by heat and interest on capital invested is considered. A comparison of the multiple and series systems showed the latter preferable for purposes of this kind.

Mr. Heisler described the series system in use for incandescent light in this city.

May 17th, 1886.

President Nipher in the chair; fifteen members present.

Prof. Trelease spoke briefly of the sensitiveness of certain bacteria to the presence of very small quantities of oxygen in the fluid containing them, and explained the experiments of Th. W. Engelmann on the assimilation of isolated cells, by the use of the bacterial test for the liberation of oxygen. The Engelmann sub-stage spectroscope for projecting a spectrum into the field of a microscope was exhibited as attached to a Zeiss stand, and the inventor's method of using it was explained. The speaker also outlined the investigations of De Vries on the tonoplasts or vacuole-plastids of vegetable-cells which he had found readily demonstrable by the use of plasmolytic reagents, one of the most convenient being a ten per cent. solution of potassium nitrate faintly tinged with eosine. The recent independent experiments of Myer, in Germany, and Laurent, in Belgium, showing the power of certain plants to form starch out of various organic substances, such as sugar, glycerine, etc., independently of assimilation, were also mentioned as important contributions to vegetable physiology.

Dr. Todd gave a general description of the artesian wells at

Jacksonville, Fla., which constitute the public water supply: he also exhibited specimens from the strata pierced in sinking the wells, the deepest being 650 ft.; 17 different strata were penetrated, consisting of sand, shell conglomerate, blue clay, and very hard sandstone. The water obtained is at first sulphurous in taste and odor, the taste disappearing after a short exposure to the air. The temperature of the water is about 75° Fahr., pressure 26 lbs.

Mr. Emory Smith made some remarks about *Dionæa muscipula* (Venus Flytrap), stating that, according to his experiments, the closing of the leaves was due to the motion of the insect, and that if these motions had ceased the leaves would open again, so that the insect would drop off or be blown away, but not absorbed by the plant.

Prof. Trelease remarked that the observations reported were very interesting, but would bear repetition with a view to determining the local causes to which the results obtained were attributed, as his own limited experiments on the Venus Flytrap were corroborative of the results obtained by Darwin and other eminent biologists, showing the plant to be truly insectivorous.

June 7th, 1886.

President Nipher in the chair; nine members present.

Dr. Alt exhibited and described the uses of Dr. Culbertson's prisoptometer for the detection of ametropia, and remarked that with certain needed improvements he thought it would become a very valuable instrument.

Prof. Nipher made some remarks on planetary influences in meteorology.

Dr. Luedeking read, by title, a paper on some experiments he had made in the use of chloroform. Referred to the Committee on Publication.

October 18th, 1886.

President Nipher in the chair; eleven members present.

Mr. Kinealy made some remarks on an ingenious form of elbow for sheet-metal piping, made from a single strip of metal cut to a peculiar form, coiled, and soldered or riveted.

Prof. Nipher illustrated a method of preparing large resistance standards for electrical measurements by films of graphite on a ground-glass plate. A set of standards from 50,000 to 1,000,000 ohms was exhibited, and the statement was made that the results of experiments now in progress on the resistance of the glass of the Holtz electrical machine would be reported to the Academy in detail on their completion.

Dr. Hambach exhibited specimens of *Cycas revoluta* from the greenhouse of Mr. D. Brown that were apparently maturing their fruit, although the species is diœcious, and no male plants were known to be in bloom in the vicinity. The plant from which they were taken has already bloomed several times, but the pistils had heretofore remained small.

Prof. Trelease remarked briefly that the fruit exhibited was not yet full grown, nor in the specimens examined had the formation of an embryo begun. Statements referring to the occasional development of sterile fruit of this species without pollination were quoted, and the tardiness attending the development of its embryo was contrasted with that of certain *coniferæ*, notably *Pinus* and *Salisburia*.

November 1st, 1886.

President Nipher in the chair; ten members present.

Dr. Todd made some remarks on the soaring of buzzards, the pelican, and other birds, attempting to explain the ability of the bird to soar and fly without any apparent movement of the wings. He offered the theory that it was due to the sculling movement of the extreme feathers, which he finds the birds have the ability to slowly rotate, though he has been unable to detect any motion from a limited study with glasses. Attention was also called to the great development of the breast muscles of birds, by which they do their flying, and to their very limited development in man. If flying machines were ever to be made a success they must be worked by legs, where there is the greatest muscular development.

Prof. Nipher gave a mathematical discussion of the efficiency of the shunt form of dynamos, illustrating the curve of efficiency by models.

November 15th, 1886.

President Nipher in the chair; fourteen members present.

Mr. Wheeler called attention to the occurrence of carbonic acid in the New Almaden quicksilver mine, in California, where it is met with in considerable quantities in the lower workings. It occasions much trouble and involves considerable extra expense in the ventilation of the mines.

Dr. Sander exhibited some specimens of sand obtained from the borings of a well at Golden City, Ark. Analysis showed that 1625 mg. of the sand contained $9\frac{1}{2}$ mg of gold, or $11\frac{1}{2}$ pounds per ton.

Dr. Curtman announced through the Secretary that he had succeeded in finding a very delicate test for aniline colors. He inverts Hoffman's Tso-nitute reaction for chloroform and thus shows the presence of fuchsine, methyl, violet, etc., in red wine, fruit, syrups, candies, or textile fabrics, in a very sharp manner. He takes a teaspoonful of the suspected red wine and adds one drop of chloroform and about a teaspoonful of caustic potash solution, and heats them gently for some time in a test tube. After one or two minutes he boils the mixture, and the peculiar penetrating odor of the benzoiso-nitrite is readily perceptible.

December 6th, 1886.

President Nipher in the chair; eleven members present.

Prof. Nipher gave an explanation of Kapp's new method of predicting the characteristics of dynamo machines and motors, so that the performance of such machines can be well determined from the drawings of the machine:

The relation between electro-motive force, magnetizing current, and speed, determines a surface. If the machine contained no iron, or if the multiplying effects of the iron were the same at all degrees of magnetization, the equation of the surface would be $E = KNC$ (1).

Were $E =$ electro-motive force, N speed of the armature, and C magnetizing current—this is the equation of a hyperbolic paraboloid.

As C rises the electro-motive force at constant speed is found to rise less rapidly than is called for by the above equation. Kapp assumes that the magnetic resistance of the iron increases as the iron becomes saturated. Calling Z the number of lines carried by the magnetic circuit, NC

the magnetizing power, and R the magnetic resistance, he assumes the relation analogous to Ohm's law: $Z = \frac{NC}{R}$ (2), where $R = K \frac{l}{S}$.

Here L is the length and S the section of the magnetic circuit, R being the specific resistance. In dealing with iron Kapp finds that if the expression for R be multiplied by a factor $\frac{\tan\left(\frac{\pi}{2}\sigma\right)}{\frac{\pi}{2}\sigma}$ where σ is the degree of saturation of the iron; the resulting expression seems to represent the true magnetic resistance. This corrected value of Z, when substituted in the equation for E, $E = \frac{ZnN'}{60 \times 10^8}$ (3).

Where N is the number of windings on the armature, gives an equation which is to hold in place of (1).

The tangent function with which R is multiplied approaches unity as P approaches zero, and it is well known that this result agrees well with determined values. There is at present some uncertainty about the maximum number of lines that can be carried per square inch of section by different irons when C is infinite.

Dr. Adams spoke of the value of the work of Froelich, Deprez, Hopkinson, and Kapp, as representatives of German, French and English advanced practice in dynamo machine construction, and as involving the modern theory of the dynamo, stating that the crowning achievement was the creation of the formulæ of Kapp with their determined constants.

December 20th, 1886.

President Nipher in the chair; ten members present.

Prof. Pritchett submitted a paper on experimental determination of the value of π, based upon a discussion of the probability of intersection when a rod of given length is thrown at random across a system of parallel lines. Referred to the Committee of Publication.

Prof. Nipher remarked concerning the statement of Mr. Fitzgerald, of Boston, that there was probably no relation between the readings of rain-gauges and wind; that his conclusion was probably due to the fact that the rain-gauges and wind-vanes observed were nearly three miles apart, and would not be borne out if the observations of both wind and rain had been made at the same place.

On motion, Mr. Robert Moore, Prof. Pritchett and Dr. Leete were appointed a Committee to draw up suitable resolutions in regard to the death of Mr. C. Shaler Smith, to be presented at the next meeting.

January 3d, 1887.

President Nipher in the chair; seventeen members present.

Mr. Kinealy presented a paper entitled "A Spiral on a Torus," in which the equation of a curve and its tangent were determined and discussed. Referred to the Committee on Publication.

Mr. McAdams presented a paper on "Some Peculiarities of the Mode of Occurrence of Fossils in the Loess," which he illustrated by numerous and admirable specimens found in the valley of the Mississippi. This paper was also referred to the Committee on Publication.

The President presented the following report for the year 1886:

Gentlemen of the Academy:

Again we stand at the beginning of a year and look back upon the year which has departed. While we have made no striking advance, we certainly have no reason to feel discouraged. We have published another number of our Transactions and have distributed it to our exchanges, and we are out of debt. The interest of our meetings has been well sustained, and we have made valuable acquisitions to our membership. If we consider the conditions which surround us, we may well turn to the future with a courage born of confidence. The future has still better things in store for us, if we but lay hold of the present with the opportunities it affords.

Progress in science depends upon the discovery of men able and willing to think and work, and upon the chance that they shall be so placed that they can control their time. There are doubtless many who might do valuable work in science, but who never discover their talent, tastes, and powers, or who do not get an adequate training in early life.

From a moral point of view, that man is most valuable as a moral agent who does not need to exert himself in order to lead a good and noble life; who does not need to waste his energies in a continual struggle against temptation.

The good deeds of such men proceed naturally and unconsciously from an inborn and inbred nobility of character, and without regard to the reward or punishment which may follow — certainly with no reference to such scandalous maxims as, "Honesty is the best policy." He does good as the bird sings its song. The quality of his ancestry and the circumstances of his early life have conspired to produce a man who does good because he is good.

It is precisely this state of affairs which results in the highest development of science. As mental cultivation becomes more widely diffused, not only are the individuals more likely to learn of their own tastes, but the probability that the capable man will get the proper cultivation is vastly increased. And this cultivation is not that which enables one to spell correctly and behave himself elegantly in society, or to enjoy elegant manners and fine painting and grand music and high mathematical analysis. A cultivated man, like a cultivated field, is one who is prepared to yield fruit, and the best evidence of the cultivation is furnished in the production of the fruit.

Such a state of affairs represents a growth. We have not yet reached it, and it cannot be reached at once. We must not expect it. But every year is increasing the number of persons who take an intelligent and rational interest in intellectual affairs, and who appreciate science not merely because of the material wealth it brings, but because of its ennobling and elevating influence upon the human mind.

During the last year we have held 17 meetings, at which 27 subjects have been presented and discussed. Nine associate members have been elected, and one has died; and I am sure that I express the sentiments of all when I say we shall greatly miss the genial presence of Charles Shaler Smith.

The reports of the Corresponding Secretary and of the Treasurer were read.

The election of officers for the year 1887 resulted as follows:

President—Francis E. Nipher.
1st Vice-President—Dr. Leete.
2d Vice-President—Mr. M. L. Gray.
Corresponding Secretary—Dr. Edw. Evers.
Recording Secretary—Mr. E. A. Engler.
Treasurer—Dr. Enno Sander.
Curators, { Chas. Lüdeking, Jas. A. Seddon.
Librarian—Dr. G. Hambach.

President Nipher appointed Messrs. Engler, Leete, and Jas. A. Seddon, Committee on Programme.

January 17th, 1887.

President Nipher in the chair; seven members present.

Mr. Nipher presented a paper entitled "A Precise Equation for the Characteristic of a Dynamo Machine," which was referred to the Committee on Publication.

January 26th, 1887.

A called meeting was held at 4 P.M. for the purpose of taking suitable action in regard to the death of Dr. William G. Eliot, Chancellor of the Washington University, and a member of the Academy.

President Nipher in the chair, and fifteen members present.

On proper motion, Judge Speck, Prof. Pritchett, and Mr. M. L. Gray, were appointed a Committee to draught suitable resolutions expressing the sentiments of the Academy concerning Dr. Eliot's death.

On motion of Prof. Snow, it was resolved to attend the funeral.

February 7th, 1887.

President Nipher in the chair; nine members present.

Mr. Gray, for the Committee appointed to draught suitable resolutions of respect to the memory of Dr. Eliot, read the following:

To the Academy of Science.

Your Committee, appointed to prepare suitable resolutions of respect to the memory of Dr. Eliot, late Chancellor of Washington University, beg leave to report—

That we feel inadequate to give proper expression to the feeling of reverence and affection entertained not only by ourselves and our Society, but by the community at large, for the character and worth of the late Dr. William G. Eliot.

His life-labors and achievements have been so blended with the religious, educational and philanthropic enterprises and institutions of our city, that a proper mention of them would involve the history of the last fifty years. during which he has lived and labored in our midst.

From the first he has been an earnest advocate and supporter of all measures looking to the moral and intellectual training and elevation of the people at large, but more especially of, the young. These aims led him into the Directory and for several years the Presidency of the Public Schools, where his services were invaluable in the organization of our present admirable Public School system, and calling into its service teachers of the best culture and highest attainments.

During the War of Secession he was most prominent and efficient in establishing and carrying on the sanitary commission for the relief of the sick and wounded, and his services in that field entitle him to the gratitude of not only our city and State, but of the whole country.

But the crowning effort of his life, and that for which his name will go down for generations, was the founding and building up, to large and permanent prosperity, of Washington University and Mary Institute and their attendant Departments.

Of these he was literally and truly the chief architect and builder, and they constitute a memorial to his energy, zeal and devotion to the public good and the welfare of the race more lasting than brass or marble.

From these institutions will flow perennial streams of enlightenment, culture, social purity and elevation, the recipients of which, in the ages to come, will arise and call him blessed.

It seems a marvel that one man, without capital, should have conceived and carried to successful completion an Institution so comprehensive and far-reaching in its aims and results. Truly it originated in and grew from his own personality, for Dr. Eliot was pre-eminently an organizer.

To great ability and fertility of invention in planning and practical sagacity of purpose, combined with gentleness of spirit, and persuasiveness of manner, that gave him access to and control over the minds of men who had means and enabled him to inspire them with his own enthusiasm, and thus secure their coöperation in accomplishing his high aims and purposes. His co-laborers are entitled to their meed of praise, but the chief merit belongs to him.

Our Academy has especial ground to honor the memory of Dr. Eliot, and our committee wish to give utterance to feelings of gratitude and thankfulness for his kindness and encouragement to our Society.

While we were wandering like Noah's dove, and "found no rest for the sole of our foot," he, with a generosity characteristic of him, opened the Ark of the University and gave us a home. As a token of our appreciation of this benevolent act we recommend that this brief memorial be placed on our records, and that the Recording Secretary furnish a copy to the family of Dr. Eliot.

Respectfully submitted.

[Signed,] { CHARLES SPECK, H. S. PRITCHETT, M. L. GRAY, } *Committee.*

The report was then adopted by the Academy.

Mr. Gray offered the following resolution:

The Academy of Science has learned with much satisfaction that its kindred Association, the Missouri Historical Society, has been the recipient, through the bounty of Mr. Henry Shaw, of the valuable historical library of thė late Bishop Robertson.

Believing that the establishment of such a source of information is a solid gain to the cause of culture in our midst, we take occasion, on behalf of the interests that our Society represents, to tender to Mr. Shaw our thanks for his generous donation to our Associate Society.

On motion, the resolution was adopted by the Academy, and the Recording Secretary instructed to send a copy to Mr. Henry Shaw.

Mr. J. H. Kinealy demonstrated how to derive Rankins' Expression for the Thermo-dynamic function in terms of the temperature and pressure (given in *The Steam Engine*, p. 314) on the supposition that the formula represented only perfect gases.

Prof. Nipher read a paper on "The Regulation of the Dynamo," which was referred to the Committee on Publication.

February 21st, 1887.

President Nipher in the chair; nine members present.

Dr. Lüdeking exhibited an apparatus for determining the iron in the atmospheric air. It consisted essentially of a Marriotte's bottle, having a Liebig's potash bulb apparatus attached to the air-tube. By this means known volumes of air were made to pass quite gently and regularly through the bulbs filled with hydrochloric acid as an absorbent. The iron was then determined in the fluid of the bulb apparatus colorimetrically by means of sulphocyanide of potassium.

The quantity of iron in a cubic foot of air was found to vary within the limits of 0.000003 and 0.000026 grammes in six experiments made in the month of February, which results are quite in accordance with those of Tissandier, obtained in Paris by an entirely different mode. The experiments will be continued through the year and the results presented to the Academy. In day-time the iron was present perhaps in ferrous state and during the night-time in ferric state.

Dr. Lüdeking was requested to write out a description of his experiments with their results, and present the same to the Academy for publication.

March 7th, 1887.

President Nipher in the chair; eleven members present.

Mr. Engler made some remarks on the method for generating a helicoid without the use of the helix, and exhibited a model of the surface thus constructed.

Mr. James A. Seddon described some experiments which he had made to determine the form of the cross section of the channel of alluvial rivers, and exhibited diagrams showing how the form of section was dependent on the slope of the consequent velocity variations.

March 21st, 1887.

President Nipher in the chair; six members present.

Prof. Nipher presented a paper on the "Characteristic of the Series Dynamo," in which he showed that the relation existing between electromotive force, speed, and current, when represented on three axes mutually at right angles, was expressed by a hyperbolic paraboloid to a degree of accuracy much within the limits of error of the machine. By the use of this surface it was possible to determine what speed the machine with constant resistance must be run to produce a given horse-power. The paper was referred to the Committee on Publication.

On motion, Mr. M. L. Gray, Dr. Sander, and Mr. Rob't Moore, were appointed to draw up resolutions expressing the sentiments of the Academy concerning the death of Capt. James B. Eads, a life-member.

April 4th, 1887.

Dr. Hulbert in the chair; twelve members present.

A paper by Prof. Trelease, entitled "Revision of North American Linaceæ," was presented by sketch, and referred to the Committee on Publication.

Mr. Engler exhibited models of a hyperbolic paraboloid.

The following resolution of respect to the memory of Capt. James B. Eads, a life-member, was received, ordered spread on the records, and the committee discharged;

To the Academy of Science.

Your Committee, charged with the duty of expressing the sentiments of the Academy concerning the character of Capt. James B. Eads, beg leave to submit the following report.

We have received with profound sorrow the intelligence of the death of Capt. James B. Eads, who departed this life at Nassau, New Providence Island, on the 8th day of March, 1887, in the 67th year of his age.

He was one of the original founders of the Academy in the year 1856, and was its first Treasurer, and for several years prior to the civil war was a member of its Finance Committee, and ultimately became a life-member.

During the years 1872 and 1873 he was President, and, when in the city, was a regular attendant upon its meetings, and took an active interest in promoting its welfare.

His inaugural address in January, 1872, covering some 19 pages of the Journal of our Proceedings, was a scholarly, clear, and lucid statement of recent discoveries in the nature of laws of light, heat, and sound, and the use and revelations of the spectroscope in scientific inquiries.

That address, and others delivered at the close of each year of his Presidency, show that his studies were not confined alone to those special problems that engaged so much of his attention, and the working out of which has rendered his name illustrious, but that his active mind was busy in exploring other fields of scientific pursuits, and were also full of encouragement and stimulus to his associates and rich in suggestions for their progress and improvement. Those addresses are worthy of careful perusal.

While we are proud of Capt. Eads as a co-worker with us in the high aims we cherish, we are prouder still of the great work and magnificent results wrought out by him in his chosen departments of labor, that have become blessings to his country and the world.

Among the old Greeks, those men of great physical strength and courage who attacked and conquered wild beasts of the woods and waters were appropriately denominated heroes, and their fame has been celebrated by historians and sung by poets, and they were magnified and worshipped as demi-gods. This was a natural tribute, from people of primitive times, to superiority in strength, prowess, and force of will, that dared to battle with hydras and monsters.

Among the Hebrews, patriarchs, prophets and legislators of their race were eulogized as heroes of faith, and this feeling sprang from a reverence for piety and high moral and religious qualities.

It is no flattery but the simple truth to say that James B. Eads united in his character and achievements the heroism of the ancient Greek and the faith of the Hebrew; for he, like them, battled with the Titanic forces of nature, and subdued and converted them into ministers of service and blessing through the combined action of intellectual power and an abiding faith in the stability, uniformity, and permanency of nature's laws.

Capt. Eads exhibited singular boldness and originality of conception, undaunted bravery and resolution in the execution of his great enterprises; and, when impediments and disasters seemed about to overwhelm him, he was so calm and self-possessed, so fertile in expedients and full of resources and devices to overcome obstacles, so persistent and inflexible of purpose, that he snatched victory and success from the very jaws of defeat.

His enterprises compelled him to cope with the mighty elements of the natural world, and his close study of their modes and laws of action enabled him, by working in harmony with these laws, to make them obedient to his will, and to use them as allies in accomplishing the grand results at which he aimed.

In view of Capt. Eads' lack of early advantages of an education, it excites our admiration that he should have attained such mental grasp, such breadth and comprehensiveness of mind; but we know these grew out of a strong, native intellect, that well might be called genius, trained by a self-imposed study, experience, and observation.

Each great undertaking of his life may truthfully be considered as a preparatory school for those that succeeded. His use of wrecking-boats on the mighty Mississippi opened to his view the laws of its currents and eddies, their modes and power of action, their agency (when properly directed and controlled) in cutting new pathways and channels, and by utilizing this knowledge, he raised sunken vessels, and removed from the river obstructions to its safe navigation. This experience was training him for other and greater works that were to follow.

When the civil war occurred and gun-boats were needed to aid the army, Capt. Eads was recognized as a competent person to construct them for service on the mighty stream with whose habits he had become familiar. and in this employment he was dealing with strong elements of the material world—with iron and steel, and their powers of tenacity, resistance, and support—and thereby he was further educated for the nobler and grander achievement of conceiving and constructing the St. Louis Bridge, the successful completion of which has placed him among the very first of the great engineers of the age and world.

Some men have genius to invent and plan, but lack the power to execute; some lack the power to conceive or plan, but are great in executive ability to carry out and accomplish what others have designed: but Capt. Eads possessed both of these matchless faculties.

With the completion of the gigantic enterprise of both planning and constructing the St. Louis Bricge he might well have rested from his labors, sure of his position in the front rank of the most skilled, courageous and daring inventors and workers; but, like Paul, forgetting the things which are behind and reaching forth unto the things which are before, he hasted by his restless energy to the undertaking of opening an unobstructed pathway from the Mississippi to the Ocean.

Through opposition, numerous discouragements, and prophecies of failure, he pressed forwards to this vast enterprise, confident in himself, and basing that confidence on the immutable laws of nature, and in due time completed this crowning effort of his life. We quote his own words at a meeting of the citizens of St. Louis in 1875: "I therefore undertake the work with a faith based upon the ever constant ordinance of God himself, and so certain as He will spare my life and faculties for two years more, I will give to the Mississippi River, through His grace and the application of His laws, a deep, open, safe, and permanent outlet to the Sea."

These are grand words, and worthy of the man and the grand undertaking concerning which they were spoken.

If to brave perils, and to overcome great difficulties and obstacles, and to where other men are afraid or unable to follow, and "out of the nettle, danger, to pluck the flower, safety" and success, entitles one to be called a hero, surely James B. Eads is worthy of the appellation.

Making the Mississippi safely navigable from the Ocean was the last great accomplished work of Capt. Eads. As an evidence of his renown and the distinguished honor in which he was held by the most competent to judge, it may be mentioned that in 1884 the Albert medal of the Society of Art, instituted in 1882 as a Memorial of the Prince Consort and given annually for distinguished merit, was awarded to Capt. James B. Eads—believed to be the only instance in which it was bestowed on an American.

His conception of the construction of a ship railway across the Isthmus of Panama was, to the common mind, most brilliant and startling, and seemed like the wild vagaries of the imagination.

Whether, if Capt. Eads had lived, the project could ever have been carried to a successful practical result is of course unknown, and could be determined only by time and the logic of events; but the boldness of the conception, and the energy and courage with which he advocated and fought for it, were characteristic of the man, and show that he had faith in its feasibility; and, having that faith, he was true to himself and his convictions, and was ready to stake his means and reputation upon its success. We believe, if it were in the power of man to realize that project, Capt. Eads, had he lived, would have accomplished it.

But his career is ended and his throbbing brain is at rest, and it only remains for us to pay this inadequate but final tribute to his memory.

[Signed,] M. L. Gray,
Ro'bt Moore,
Enno Sander.

April 14th, 1887.

President Nipher in the chair; nine members present.

Prof. Nipher exhibited and explained the uses of a Kaulrausch's amperometer, and a simple form of dynamo machine.

May 2d, 1887.

President Nipher in the chair; fifteen members present.

Prof. Potter described an interesting example of iron-ore deposit at Iron Mountain, Mo., being a surface deposit of iron ore of Huronian or Lower Silurian age, since covered by strata of Lower Silurian rocks.

May 16th, 1887.

President Nipher in the chair; twelve members present.

The Committee appointed to draught suitable resolutions in regard to the death of C. Shaler Smith, a member of the Academy, presented through its chairman, Mr. Rob't Moore, the following:

Charles Shaler Smith was born in Pittsburg, Pa., Jan. 16th, 1836. His father, Frederick Ross Smith, died when the son was but nine years of age, and his mother died when he was but sixteen. Up to this time he had attended a private school, but with his mother's death his days of formal schooling ended, and his days for work and study began. The same year, 1852, he began the study of his profession in what was then the only school open to American engineers, the school of practice, by entering as rodman an engineer party on the Mine Hill and Schuylkill Haven Railroad. From this position he was presently promoted to the rank of leveller and then to that of assistant. After his services on the Schuylkill Haven Railroad he was for a short time employed at Pittsburg, and then, in 1854, in railroad surveys in the mineral regions of Lake Superior. His final term of pupilage was in the service of the Louisville & Nashville Railroad, which he entered in the summer of 1855 as an assistant with the late George McGood, then chief engineer. For two years he was employed in Tennessee, at first in local and then in construction.

In 1857 he was transferred to the chief engineer's office at Louisville as an assistant to Mr. Albert Fink, then engineer in charge of bridges and buildings. It was here in Mr. Fink's office that his attention was first directed to the special department of engineering which became afterwards his life-work—the designing and construction of bridges.

In October, 1859 when lacking yet a few months of completing his 24th year, he left the service of the Louisville & National Railroad to take the position of Chief Engineer of bridges and buildings on a railroad in North Carolina, where he was found at the outbreak of the war in 1861.

As was almost inevitable from his surroundings, he entered the service of the Confederacy as an engineer, and remained in it until the close of the war, taking rank as a Captain of Engineers. During this period, as Chief Engineer of the Augusta District he constructed the Confederate State powder-works, one of the largest that had then been built.

The close of the war was signalized by his marriage, May 23d, 1865, to Miss Mary Gordon Gairdner, of Augusta, Ga., and by his removal to Baltimore, where he resumed the practice of his profession as an engineer of bridges. In 1866 he associated himself with Messrs. Benjamin and Charles Latrobe as partners in the engineering firm of Smith, Latrobe & Co., which in 1869 became the "Baltimore Bridge Co.," an organization which continued until 1877 with Mr. Smith as Mr. President and Chief Engineer.

In 1868 Mr. Smith left Baltimore and came with his family to St. Charles, Mo., to take charge as Chief Engineer of the bridge at that point over the Missouri river. In 1871, upon the completion of the St. Charles bridge, he changed his residence to St. Louis, where he remained until his death, which took place December 19th, 1886, after an illness of nearly two years.

Few engineers of his time have done as much work as Mr Smith. His bridges are numbered by hundreds, and include four over the Mississippi, one over the Missouri, and one over the St. Lawrence. Some of them mark eras in the history of this department of engineering; for he had both the ability and the courage to leave precedent behind him, and some of the methods of construction which he introduced have permanently increased the resources of his profession. Amongst these may be noted the use of iron trestle-work, which he was the first to employ on any important scale by building, in 1868 and 1869, nine structures of this kind, ranging in height from 50 to 135 ft.

But his most important professional work was without doubt his practical demonstration of the uses and value of the cantilever, in the employment of which he was, in this country at least, the pioneer. His first use of the cantilever was in 1869, when he erected on this method, without scaffolding, a 300-ft. draw-span over Salt river in Kentucky. His next work of this kind was the bridge, built in 1876-7, on the line of the Cincinnati Southern Railroad over the Kentucky river. This consists of 3 spans of 375 ft., each with a height of rail above the bed of the river of 276 ft. This great height as well as the danger from freshets, which in this river are very frequent and severe, made the ordinary methods of erection very expensive as well as very hazardous.

Mr. Smith resorted to the method which he had already used at Salt river, which has since been used with such marked success at Niagara, namely, that of building the bridge out of piece by piece without the aid of scaffolding; afterwards, by severing the bottom chords of the side-spans, they were converted permanently into true cantilevers. This was one of the boldest and most successful of Mr. Smith's works, and, if he had done nothing else, would mark him as one of the first engineers of his time.

Still another and hardly less interesting example of this class of structures is the bridge over the Mississippi river, between Minneapolis and St. Paul, near the falls of Minnehaha; whilst the last, and in some respects the most interesting of all, is the bridge over the Lachine Rapids of the St. Lawrence river, near Montreal, on which he was engaged at the time of his death, and which is still in course of erection. When completed this will be one of the greatest works of its kind, and it is a worthy ending of a professional career of exceptional brilliancy.

Owing to his native reserve Mr. Smith was much less widely known as a man than as an engineer; but by those who were so fortunate as to come into intimate relation with him, he will be ever remembered more for his personal traits than for his skill in his profession.

Courteous, honorable, and just in his dealings with all men, he was especially considerate and helpful in dealing with his subordinates; and no stronger testimony to his personal worth can be offered than the loyal and abiding friendship for him which is manifested by every one who was ever in his service. So that, in losing him from our number, the Academy loses not only an engineer of the rarest skill, but also one of the purest and best of men.

[Signed,] Rob't Moore,
Jas. M. Leete,
H. S. Pritchett.

Report was accepted and ordered spread on the record of the Academy.

Dr. L. Bremer presented a verbal communication describing the methods and apparatus in use, and exhibited some of the results attained in the cultivation of Bacteria.

June 6th, 1887.

President Nipher in the chair; eleven members present.

Mr. O. B. Wheeler read a paper on "The Secondary Base in Geodetic Surveys," which was referred to the Committee on Publication.

Mr. L. H. Pammel made a few remarks on "The Behavior of Bees on the Flowers of the *Phlomis tuberosa*," about as follows:

A species of *Xylocopa* regularly cuts with its mandibles two or three longitudinal slits on the upper side of the tube of the corolla in order to get at the nectar, which is produced in great abundance and contained in the nectary which occupies the lower third of the tube of the corolla. There are also well developed nectar glands immediately underneath the ovary. The nectar is protected from unwelcome guests by a rim of hairs on the inside of the tube of the corolla, at the slight enlargement above the nectary. The purple corolla of the flower and the numerous auxiliary heads make it very conspicuous. It is visited and pollinated by several species of bees. The corolla is two-lipped; the upper lip arches over the lower and at the time of pollination is nearly horizontal, so that an insect alighting on the lower lip and forcing the upper lip back, to enter, has its thorax dusted with pollen from the stamens which are included in the upper lip. This pollen is then carried by the bee or other insect to other plants.

Dr. Adams showed an instrument which had been intended for a Mille-Ampère meter, but which he said could not be so called as the instrument was not all reliable. Part of the scale on it was graduated to read Mille-Ampère, and part to read Ohms.

Prof. Nipher presented a paper on "The Scale Value of the Dhlman Electrometer used by Dr. Wislizenus," which was referred to the Committee on Pnblication.

October 17th, 1887.

President Nipher in the chair; ten members present.

Dr. Todd exhibited the wing of a pelican which he had partially dissected to illustrate the explanation given by him at a meeting of the Academy Nov. 1st, 1886, of the soaring power of certain birds.

Prof. Nipher exhibited a number of rifle balls which had been shot by him from a Winchester rifle into water, and which showed a variety of distortions due to the form into which the ball had been cast. The experiment showed that balls with a sharp conical point suffered very little distortion and very much less than those of other forms, and could penetrate the water with much greater velocity.

November 7th, 1887.

President Nipher in the chair; twelve members present.

Dr. Hambach exhibited a series of photographic views of Yellowstone National Park.

Prof. Nipher read extracts from a paper "On the possible Results to be expected from a Reversion of the Second Law of Thermo-Dynamics," suggested by G. J. Stoney's paper on the same subject, published in a recent number of the Transactions of the Royal Society of Dublin.

November 21st, 1887.

President Nipher in the chair; thirteen members present.

Mr. H. A. Wheeler read a paper by W. J. McGee, U. S. Geologist, entitled, "Notes on the Geology of Macon County, Mo." Referred to the Committee on Publication.

Prof. Nipher exhibited a steam-pipe, six inches in diameter, which had been capped with a plain cast-iron head. The head of the pipe (9 lbs.) had been blown off by a ball from a Winchester rifle. He explained that this had been done by standing the pipe on its closed end and filling it with water. The ball had been fired down vertically upon the water. The floor upon which the pipe stood had yielded, and the head of the pipe had been forced down by the water pressure with such quickness that the pipe could not follow. The head of the pipe had therefore been pushed off. To do this required a force of between 135,000 and 150,000 lbs., or about 70 tons. The ball was a 38 calibre ball and the charge of powder was 40 grains. The pipe was 5 ft. long, and exclusive of the head weighed 96 lbs. The ball was greatly flattened by the water, but did not batter on the bottom.

Mr. J. A. Seddon exhibited a chart showing the results of a series of precise levellings made by the Missouri River Commission between St. Louis and St. Charles.

December 5th, 1887.

President Nipher in the chair; six members present.

Mr. W. G Eliot, Jr., presented a paper on some measurements of the trimorphic flowers of *Oxalis Suksdorfii*, Trelease, in which the heterogony of the species was clearly shown; and the mutual relation of stamens and pistils in the three forms of flowers were graphically represented in a series of curves obtained by plotting the measurements.

In commenting upon the paper, Mr. Trelease called attention to the dymorphism of *Oxalis violacea*, as it occurs through the Upper Mississippi Valley, from the suppression of the mid-styled form, and by the means of a similar series of curves contrasted this species with *Oxalis Suksdorfii*, calling especial attention to the unexplained fact that in both species the mid-length stamens of long-styled flowers are depressed so far that they fall within the average of the short-length parts considerably below their normal positions.

On motion of Mr. Wheeler, the paper was referred to the Committee on Publication, and the Academy passed a vote of thanks to Mr. Eliot.

A drawing of a mechanical device, designed by Mr. H. Newington for drawing the various conic sections, was exhibited, and the mathematical problems involved were discussed.

Prof. Nipher exhibited a second cast-iron cap, which had been torn off a six-inch pipe to which it was screwed, by shooting into the pipe when filled with water with a Winchester rifle, as described in the minutes of the meeting of the Academy, Nov. 21st, 1887. In this case two shots had been required. He also showed the effect produced upon the iron of the cap by firing upon it directly through the air only.

December 19th, 1887.

President Nipher in the chair; eight members present.

A paper by Dr. Lüdeking on the "Anomalous Densities of Fused Bismuth" was read by the Secretary. From experiments made with bismuth between 275° and 300° C. it was shown that this metal exhibited the phenomenon of anomalous densities in precisely the same manner, though in a less degree, as does water. Referred to Committee on Publication.

Prof. Nipher made some remarks on the graphical representation of certain mathematical functions, using as examples for illustration the functions $\sin^2 a$ and $\cos^2 a$.

Mr. Engler exhibited a silk-thread model of a hyperboloid of revolution of one nappe, showing the transformations of the surface between the cylinder and cone, which are its limits, and the rectilinear elements of both generations.

January 2d, 1888.

President Nipher in the chair; seven members present.

Prof. Nipher gave a discussion of the change in the position of the gravitation of equipotential surfaces in a region occupied by a liquid, the discussion involving the density of the liquid and of the testing unit of the mass.

Dr. Lüdeking answered some questions concerning his paper on "Anomalous Densities of Fused Bismuth," read at the last meeting.

Prof. Nipher gave the generally accepted explanation of the effect of oil in preventing the breaking of waves, in response to a question by Dr. Hulbert.

January 16th, 1888.

President Nipher in the chair; fourteen members present.

The President made the following annual report:

GENTLEMEN OF THE ACADEMY:

At the close of another year we pause for a moment before entering upon the duties of the new year. I think we may fairly say that we have made definite progress—that we are carrying out the objects for which the Academy was founded. I wish that we might be able soon to realize the great prosperity to which we have been looking forward so long, that we might be in possession of a home of our own, and that we might feel that our valuable Library was safe against fire. Perhaps if we continue to justify our right to exist by the publication of the scientic work of our members, some citizen will yet put us in possession of these good things. As I take it, the main object to be accomplished by us, in addition to such advancement as we may be able to make in scientific learning, is to arouse a local interest in scientific work.

There are occasionally young men to be found, who need only to be once initiated into the joys of the student of science, and they develop into great and useful men. If we can succeed in producing one man of this kind, we shall have rendered a valuable service.

It is to be expected that our Academy shall be fairly representative of the condition of science in our city, and of the scientific features of the region which we inhabit. Money alone cannot bring us scientific men. We must furnish the conditions which will make it possible for them to live and grow here, and money is only one of those conditions.

It is of course desirable that our publications shall be mainly the productions of our own members, but, as we agree that we as an Academy shall represent the region in which we live, we may fairly welcome the productions of others who may have strayed upon our domain, and who may have something to teach us of our local geology, or of the plants or animals which inhabit our forests, our prairies, our rivers, or our lakes; or who have studied the archæology or ethnology of the primitive races who preceded us.

In this connction, I take pleasure in announcing to you, that the Missouri Weather Service finishes with the year 1887 the first ten years of its existence. A report on the rainfall and temperature of our State is now in process of preparation and will be in readiness for the present number of our Transactions, which we hope to issue soon.

Another matter which, as it seems to me, concerns the future of our Academy, I wish to touch upon here. It has been the custom for the Academy to elect the same officers from year to year. I fear that this has sometimes come about through excessive courtesy to those holding these offices. I think that some method of choosing our officers ought to be devised which will enable each person to vote for the member whom he desires to see fill an office, and without anything else to influence his vote. In most of the offices, there is no doubt that the interests of the Academy will be promoted by a rotation in office. When one takes upon himself the responsibility of an office, he commits himself more fully to advance the interests of the Academy. It becomes a duty to attend the meetings, and the incentive to contribute something to the interest of the meetings becomes greater. I most earnestly urge this matter upon the attention of the members, and hope that it will receive your serious consideration. The nominations should be wholly by informal ballot, and without any open nomination, in order to secure a wholly unbiased action.

Regarding our financial condition, we are in a prosperous condition, in a small way; that is to say, we are out of debt, and have means to publish the forthcoming number of our Transactions. We are continually extending the list of our exchanges, receiving in return the valuable publications of learned societies in all parts of the world. Our thanks are continually due to the enlightened policy of Washington University in providing for us the comfortable rooms which we occupy here.

During the past year there have been 16 regular and one called meeting. The highest attendance has been 18, the lowest 7, and the average 11 and a fraction. Thirteen papers have been presented and referred to the Publication Committee, and many subjects not intended for publication have been brought before us for our mutual interest and instruction.

By the death of Dr. W. G. Eliot and Mr. J. B. Eads the Academy loses from its membership two men who have not only done much to advance the interests of our institution, but whose influence and labor were always felt whenever the higher needs of society were involved.

The reports of the Corresponding Secretary and Treasurer were also read.

The annual election of officers for the year 1888 resulted as follows:

President—Francis E. Nipher.
1st *Vice-President*—Jas. M. Leete.
2d *Vice-President*—M. L. Gray.
Corresponding Secretary—Edward Evers.
Recording Secretary—E. A. Engler.
Treasurer—Enno Sander.
Librarian—G. Hambach.
Curators, { G. Hambach, Chas. Lüdeking, Jas. A. Seddon.

February 6th, 1888.

President Nipher in the chair; eleven members present.

Prof. Trelease explained by illustrations on the blackboard what is meant by the karyokinetic figures of vegetable-cells, and showed under the microscope a slice of *smilaceas* with the nuclei undergoing division preparatory to the segmentation of the cells in a growing petal, and remarked on the general similarity of cell-division in animals and plants.

February 20th, 1888.

President Nipher in the chair: eleven members present.

Prof. Trelease, for the Committee appointed to prepare a suitable memorial in respect to the death of Dr. Asa Gray, reported the following:

ASA GRAY.

In the death of Prof. Asa Gray, of Harvard Univerity, which occurred Jan. 30th, shortly after the completion of his 77th year, American Science loses a leader greater than any other known to the present generation, and it is fitting that the St. Louis Academy of Science should place on record its affectionate appreciation of the man and his work.

As a teacher Dr. Gray was successful in imparting knowledge and in stimulating thought. Though it may be thought he had not that special talent for making naturalists so remarkably developed in Agassiz, he possessed in an unusual degree the power of interesting others in his specialty, and the present wide-spread taste for botanical work in the country is largely attributable to the example which he himself set, and to the force and clearness of his popular writings.

His scientific work marks an epoch in the history of American botany. Entering the field at a time when the labor of Michaux, Prush, Nuttall, Elliott, and others, had placed their science upon a fairly firm foundation for the older States, while the great interior of the continent was as yet entirely unknown, it fell to his lot to largely guide the botanical exploration of one section after another, and to perform the severe task of elaborating and describing the large collections that were brought in. So onerous was this labor that it formed his chief occupation for half a century, and so thoroughly well has it been done that future students must start from his work as a foundation in any study of the botany of North America; while the enormous herbarium upon which his work was done, and which was generously donated to Harvard University many years ago, will, it is to be hoped, long preserve the evidence upon which his conclusions were based.

Early in his botanical career, in connection with his friend and teacher, the late Dr. Torrey of Columbia College, he entered upon the task of publishing a Flora of North America, little knowing at first that his life must be given to the preliminary working out of new material before its completion could be seriously contemplated. In his later years, when this preliminary work had been largely finished, it was still his hope to see such a Flora brought out, though he realized that he could hardly expect to carry the undertaking to a conclusion unaided. Unfortunately for science the work is now, at his death, only about one-third done, and if it is completed it must be by other hands. Yet it should be added that the part already published includes the large and difficult order *Compositæ*, of which he was especially a master.

Though a systematic botanist, trained to the traditions of the early part of the century, Dr. Gray was a man of broad views and large information, and his keen insight and sound judgment placed him foremost among American adherents of Darwin's theory of the mutability of species, and enabled him to keep well abreast of the progress made in those branches of natural science with which he was less directly concerned. For many years he has occupied the unquestioned position of a leader in botanical matters, to whom all looked for just approval or condemnation. A man of warm impulses, the kindest of approvers, and the most exact of critics, he was, withal, far too thorough in his scientific habits to allow personal likes or dislikes to bias his judgment of the work of others; while his own research was always carried on in the unassuming spirit of a master.

Notwithstanding the duties of an active professorship, which he held for about thirty years, and his unceasing original investigations, he found time to give thought and labor to scientific undertakings far removed from the sphere of his own work. For some years previous to his death he acted as a Regent of the Smithsonian Institution; and it is well known in St. Louis that he was the trusted counsellor of Mr. Henry Shaw in planning for the botanical future of the garden of which this city is justly proud, and in the establishment of a school of Botany in connection with Washington University.

Recognizing the advancement that he has given to botanical pursuits, the simple love of truth for its own sake that guided his life-work, and the purity and majestic beauty of his character, the Academy of Science desires to record its appreciation of a model life, the memory of which will long endure, and to tender its sincere sympathy to the University and family upon whom his loss falls heaviest.

[Signed.] WM. TRELEASE, E. A. ENGLER, J. M. LEETE, } *Committee.*

The report was accepted, ordered to be spread on the minutes, and published in the Transactions of the Academy.

Prof. Nipher exhibited the apparatus and showed the method of investigating the motion of a body rolling on a plane.

Dr. Hambach exhibited the rattles of a rattlesnake which had been brought from Florida by Mr. Geo. Mills and presented to the collections of the University. The specimen contained 31 rattles. As there seemed to be some doubt as to the genuineness of the specimen on the part of the authorities of the Smithsonian Institution, to whom it had been sent for examination, Dr. Hambach said he would give it a careful inspection and report later.

A paper presented by Emil Brendel, of Cedar Rapids, Iowa, entitled "Synopsis of the Family of *Pselaphidæ*," was referred to the Committee on Publication.

March 5th, 1888.

President Nipher in the chair; eight members present.

Prof. Nipher made a report on ten years' rainfall of the State of Missouri, showing maps of normal rainfall for the months, seasons, and year.

On motion, the paper was referred to the Committee on Publication.

March 19th, 1888.

President Nipher in the chair; seventeen members present.

In behalf of Mr. Henry Shaw, Prof. Trelease presented the

Academy with a copy of the "Botanical Works" of the late Dr. Engelmann.

On motion of Prof. Pritchett, a vote was passed expressing to Mr. Shaw the thanks of the Academy for the gift; for the aid which the publication of this work, due solely to his munificence, renders to the cause of science, and for the great service he had rendered to the Academy by placing in permanent form and making everywhere accessible to scientific men the works of Dr. Engelmann, for many years our honored President.

The Secretary was instructed to inform Mr. Shaw of the action of the Academy in a suitable letter.

Prof. Trelease presented a description accompanied by a number of specimens of an undescribed Puff-ball which he had discovered in this region. Referred to the Committee on Publication.

Mr. Wm. McAdams exhibited and read a description of a fossil tooth found in the St. Louis limestone near Alton, Ill., and supposed by him to have belonged to a very old Saurian. The paper was referred to the Committee on Publication. He also exhibited several specimens of *Geniatites*.

Mr. M. L. Gray announced that the Supreme Court had affirmed the decision of the lower court, by which the property left by Mr. Lucas to the Missouri Historical Society and the Academy of Science jointly was to be equally divided between these two associations according to the conditions of the will.

The President called attention to the value of Mr. Gray's service in looking after this matter, and expressed to him for the Academy its appreciation of his kindly offices.

April 2d, 1888.

President Nipher in the chair; thirteen members present.

Mr. Seddon presented the equation for the equivalent in hydraulic flow of the tangential force acting on a solid sliding down an inclined plane:

The equation was

$$R = \pi AH.$$

in which R = total tangential force in a given length.
π = density of fluid.
A = arm of cross-section.
H = fall in the given length.

Mr. Engler exhibited a model and explained some of the properties of an elliptic hyperboloid.

Prof. Nipher exhibited and described the operation of a Thompson calorimeter.

April 16th, 1888.

President Nipher in the chair; eight members present.

A letter from the President of the American Philosophical Society was read inviting the coöperation of this Academy in perfecting a language for learned and commercial purposes, based on the Aryan vocabulary and grammar in their simplest forms, and to that end purposing an International Congress, the first meeting of which shall be held in London or Paris.

May 7th, 1888.

President Nipher in the chair; four members present.

Dr. Hambach read a paper on pathologic conditions of *Pentremites*, and exhibited specimens in which a portion of the ambulacral field had been destroyed, and subsequently restored by a process of secretion. The paper was referred to the Committee on Publication.

Mr. Engler exhibited and described a model of an elliptical torse.

May 21st, 1888.

President Nipher in the chair; sixteen members present.

A paper by Dr. C. Lüdeking, entitled "Contribution to the Chemistry of Combustion," in which he described experiments showing that nitrogen of the atmosphere takes part chemically, generally, in the combustion of carbon compounds, forming transiently cyanogen or hydrocianic acid, was read by the Secretary. Referred to the Committee on Publication.

Prof. Nipher read a paper showing the limiting conditions for the winding of shunt dynamos. Referred to the Committee on Publication.

June 4th, 1888.

Vice-President Dr. J. M. Leete in the chair; eleven members present.

Hon. Wm. McAdams read a paper entitled "Some Peculiarities of the Old Ganoid Fishes of the Mississippi River," and exhibited a number of specimens. The paper was referred to the Committee on Publication.

Prof. Todd presented specimens of birds' wings to illustrate a theory of flight, and described the mode of their operation. He was requested to prepare a paper on the subject and to submit the same to the Committee on Publication.

Mr. Pammel made a few remarks on the color-variation in *Delphinium tricorne*, a native species common in this region. The colored sketches were made by Miss Hoke. He also called attention to *Poa cristata*, a common grass in this region which has usually passed for *Poa annua*. He was asked to write out his remarks and present the paper for publication.

Adjourned until the third Monday in October.

EDMUND A. ENGLER,
Recording Secretary.

PROCEEDINGS.

October 15*th*, 1888.

President Nipher in the chair; nine members present.

Prof. Nipher exhibited proofs of Rain Charts to illustrate his report on "Ten Years' Rainfall of the State of Missouri," which was referred to the Committee on Publication on March 5th.

Prof. Nipher also made a communication on the relation between rainfall and river discharge in the Upper Mississippi valley. He presented a diagram showing the average monthly values of rainfall, in cubic feet per second, over the region draining past St. Louis, and simultaneous values of river discharge at St. Louis. It was proposed to continue the investigation for other sections of the Mississippi and Ohio valleys. The communication was referred to the Committee on Publication.

Mr. J. A. Seddon gave a discussion of the theoretic variation of the intensity of light through a tube filled with various colored solutions, showing that the general equation was

$$CL = \frac{1}{E^{\delta y}}$$

where

L represented the intensity of the light,

δ " a constant dependent on the opacity of the solution,

and y " the length of the ordinate of any point in the tube.

He also pointed out how this might be used as a measure of light and of the opacity of different solutions.

November 5th, 1888.

President Nipher in the chair; eleven membrs present.

The librarian announced that the Academy had received as gifts Dr. Anton Fritsch's "Vögel. Europa's" from Mr. Julius Hurter, and Judge Holmes' "Realistic Idealism in Philosophy itself" from its author. The corresponding secretary was instructed to express to both these gentlemen the thanks of the Academy for their valuable donations.

Dr. Todd exhibited a skull taken from the body of an old woman having a number of anomalies in structure: Both clavicles were rudimentary; the inter-frontal suture persisted in its upper part to the extent of one inch, leaving a gap ½ inch wide extending from near the coronal suture; the parietal bones were in two parts each, the separating sutures running parallel to the inter-parietal; there was the appearance of a very imperfect thiId dentition in the anterior dental arch of both jaws; the zygomatic arch on each side was incomplete; there was also marked irregularity in the relation of the inferior maxillary to the temporal bone.

Mr. Engler made some remarks concerning properties of the cone of revolution.

Mr. Jas. A. Seddon remarked, with reference to the method he described at last meeting of measuring the opacity of different colored solutions, that the "dark point" involved an error of about 30%, due in large part to the accommodation of the eye to the reduction of the light.

November 19th, 1888.

President Nipher in the chair; eleven members present.

A paper by Mr. J. H. Kinealy on "The Pressure of the Wind on Roofs and Inclined Surfaces" was read by Mr. Jas. A. Seddon, and referred to the Committee on Publication.

A paper by Dr. Lüdeking on "The Hydration of Colloids" was read by Mr. Thacher, and referred to the Committee on Publication.

Mr. Engler exhibited some drawings in explanation of his remarks at last meeting on the cone of revolution.

The Committee on Publication announced that Nos. 1 and 2 (a double number) of Vol. V. of the Transactions had just come from press, and exhibited a sample copy.

December 3d, 1888.

President Nipher in the chair; six members present.

Dr. Hambach exhibited some petrified seeds of *Celtis*, found in the subcarboniferous limestone at Boonville, Mo.

December 17th, 1888.

President Nipher in the chair; eleven members and twenty visitors present.

Mr. Jas. A. Seddon presented a paper on "The Absorption of Moisture by Swedish Filter-paper."

Prof. Pritchett made a statement of the preparations made by the Observatory of Washington University to observe the total eclipse of the sun visible in California, Jan. 1st, 1889, and gave a short discourse on the observations of former eclipses.

January 7th, 1889.

Vice-President Dr. J. M. Leete in the chair; ten members present.

Hon. Wm. McAdams read a paper on "A Mound Builder's Skull," and exhibited the skull and some of the bones.

Mr. Pammel made some remarks on Bacteria Methods as applied to the study of higher Fungi, and exhibited a series of specimens.

The annual report of the Corresponding Secretary was read and accepted.

The Treasurer presented a report, which, upon the recommendation of the auditing committee, was accepted.

The following officers for the ensuing year were unanimously elected:

President—Francis E. Nipher.
1st Vice-President—Jas. M. Leete.
2d Vice-President—M. L. Gray.
Corresponding Secretary—Edward Evers.
Recording Secretary—E. A. Engler.
Treasurer—Enno Sander.
Librarian—G. Hambach.
Curators, { Chas. Lüdeking, Jas. A. Seddon. G. Hambach.

January 21st, 1889.

President Nipher in the chair; fourteen members present.

Mr. Letterman presented the Academy with a portfolio containing sixteen Maps accompanying the Report on Forest Trees of North America, by Prof. C. S. Sargent. A vote of thanks was given to Mr. Letterman for this valuable donation.

Prof. Pritchett gave an informal report of the Washington University Eclipse Expedition, and its work at Norman, California, on January 1st, 1889.

February 4th, 1889.

President Nipher in the chair; nine members present, also Prof. E. S. Morse of Salem, Mass.

Prof. Trelease presented for publication a revision of the species of *Ilicineæ* and *Celastraceæ* belonging to the flora of the United States, and called attention to a few facts connected with their present and geological distribution, and their biology. Referred to the Committee on Publication.

In response to a call Prof. Morse made some very interesting remarks on the methods of arrow-release employed by different tribes and races of men throughout the world, from which it appeared that the method employed depended upon the degree of advancement, and was therefore an index of their civilization.

Prof. Nipher reported that since 1837 we have had 25 Januaries in which the mean temperature has been above that of last month, viz., 32°.0. The highest observed temperature on any day was 68°.2. This is a very ordinary temperature for January. At some time during the last 50 years that temperature has been reached on 25 out of the 31 days of January.

February 18th, 1889.

Vice-President Dr. Leete in the chair; seven members present.

Hon. Wm. McAdams presented a paper entitled "How the Mound Builder made his Stone Axe," and exhibited a number of stone implements. He thought there were unmistakable indications to show that these implements were made by chipping off the stone with pieces of flint and not by grinding.

March 4th, 1889.

President Nipher in the chair; three members present.

Prof. Nipher exhibited a chart showing the average temperature of February for the past 52 years, from which it appeared that the past month (February, 1889) was slightly colder than the average.

He also exhibited a drawing of a new pressure gauge that he had designed for testing steam gauges and engine indicators up to 300 lbs. pressure.

March 18th, 1889.

President Nipher in the chair; four members present.

Prof. Nipher remarked that the winter of 1888–9 has been slightly warmer than the average, the temperature having been 34°.3, while the normal is 32°.2. The warmest winter on record was 40°.8 in 1877–78, the coldest 25°.1 in 1884–85; the extreme range between our warmest winter and coldest winter is therefore 15°.7. During the last six years the winters have been abnormally cold, one of them having been the coldest on record. It is this fact which makes the present winter seem abnormally warm. As a fact, however, we have had 18 winters in 52 years which were warmer.

Prof. Nipher gave a short verbal statement of the development and recent improvements in the construction of the Dynamo.

April 1st, 1889.

President Nipher in the chair; six members present.

Prof. Nipher made a few remarks showing how the magnetic resistance of iron is determined.

April 15th, 1889.

President Nipher in the chair; thirteen members present.

A paper by Dr. Lüdeking on "The Electrical Conductivity of Colloids" was referred to the Committee on Publication.

A paper by Mr. J. H. Kinealy entitled "Mathematics of Ventilation" was read by Prof. Gale.

A paper on "North American *Rhamnaceæ*" by Prof. Trelease was read by title and referred to the Committee on Publication.

May 6th, 1889.

President Nipher in the chair; six members present.

Dr. Hambach reported for the Curators that the exchange of fossils for pottery offered by Seever & Co. had been made, and exhibited the fossils.

Mr. Engler made some remarks on the refraction of parallel rays of light through a sphere.

Mr. Nipher gave a discussion of the action of transformers in electric lighting by alternate currents. The discussion was mainly mathematical, and was participated in by other members.

Mr. Seddon made some remarks on the time of complete discharge of a reservoir as compared with the time of discharge at a constant rate.

May 20th, 1889.

President Nipher in the chair; ten members present.

Prof. Nipher read a paper entitled "A New Discussion for the performance of a Steam Engine," in which, by representing horse-power, pressure and speed on 3 axes at right angles to each other, he showed that their relations were correctly represented by a hyperbolic paraboloid, and discussed the properties of the surface. The paper was referred to the Committee on Publication.

Adjourned to third Monday in October.

September 24th, 1889.

On call of the President, the Academy met at 8 P.M. in the Academy rooms to take suitable action in regard to the death of Dr. A. Wislizenus, a charter member. President Nipher occupied the chair, and there were present also Messrs. Engelmann, Speck, Comstock, Trelease, Baumgarten, Hambach, and Engler.

With the proviso that the usual formality of appointment of chairman of committees be waived in this case, Judge Speck moved that the President appoint a committee of three to draft a suitable memorial to Dr. Wislizenus. Seconded and carried.

On motion of Prof. Trelease, the President of the Academy was asked to serve on the committee.

The President appointed Drs. Baumgarten and Engelmann to fill the other two placess on the committee.

October 21st, 1889.

Vice-President Dr. Leete in the chair; seven members present.

Dr. Baumgarten, for the Committee appointed to draft a suitable memorial in respect to the death of Dr. A. Wislizenus, reported that the formal document[1] which the committee would present for publication was in the hands of Dr. Engelmann, and would be presented by him at the next meeting of the Academy. The committee also submitted a brief memorial for incorporation in the Proceedings of the Academy:

In Memoriam Adolph Wislizenus, M.D.

The St. Louis Academy of Science grieves to record the loss by death of one of its founders, Dr. Adolph Wislizenus.

The name of Dr. Wislizenus will ever be honorably associated with the history of science in St. Louis. Immediately after coming to St. Louis, he in 1839 traveled as far west as Utah in a company of fur traders, where he gained experience of great value to him in his later work. In 1846–7 he made a tour of Northern Mexico, where he gathered valuable collections, resulting in a memoir published by the U. S. Government in 1848. He with his friend, Dr. Engelmann, had taken an active part in the work of the Western Academy of Natural Sciences, which was organized in 1837. Later, in 1856, he took part with Engelmann, Shumard, Eads, Prout, and others, in the organization of the St. Louis Academy of Science.

In 1861 he began a laborious series of observations in atmospheric electricity, using for that purpose the best instruments then known. He hoped to be able to devise some method of predicting the arrival of storms. This work was carried on for over eleven years. Although his hopes in this direction were not realized the failure was not his failure, but was one of the many cases where investigation is necessary in order to show the exact facts. A negative result is never without value.

His work during his tour to Mexico will be regarded as his most valuable contribution to the science of his time, and was publicly acknowledged by Humboldt as of value to him in his studies in that region.

It too often happens that we fail to appreciate the labors of those who have done their work in a former generation. The knowledge which they so painfully acquired, often under the most discouraging circumstances, has become the common property of students everywhere; it has lost the freshness and interest which it possessed to them. But it is nevertheless true that the advantages of the present are to be regarded as the heritage transmitted to us from the past. In holding in honored remembrance the worthy men who have preceded us, we simply recognize our indebtedness to them for what we have received from them.

The report of the committee was accepted.

November 4th, 1889.

Vice-President Leete in the chair; fourteen members present.

Prof. Wheeler made some remarks on the Westphalian coal field.

Dr. Engelmann presented by title a memoir of Dr. A. Wislizenus, which was referred to the Committee on Publication.

A gift from Dr. Litton of a number of books for the Academy library was received; a vote of thanks to Dr. Litton was passed.

November 18th, 1889.

President Nipher in the chair; seventeen members present.

The Academy was honored by the presence also of Prof. Morse of Salem, Mass.; Dr. Hinrichs, and Dr. Green, of St. Louis.

Prof. Morse, upon the invitation of the President, gave a very intereresting account of his examination of ancient and modern shell heaps.

December 2d, 1889.

President Nipher in the chair; seven members present.

Mr. Seddon called attention to the reasons for thinking that in the passage of floods down the Upper Mississippi there was relatively a very rapid transmission through Lake Pepin, and offered some theoretic considerations for the opinion that its passage down was here, at least, similar to that of a "plane wave."

December 16th, 1889.

President Nipher in the chair; twelve members present.

A paper by Dr. C. Lüdeking on "The Sparking of Iodine" was read. The paper was an account of some experiments to show that Mr. C. P. Smyth, Astronomer Royal of Scotland, was mistaken in supposing that the sparking of Iodine was due to a transformation of iodine into hydrogen. Referred to the Committee on Publication.

Dr. Hambach exhibited and described the habits of several interesting orchids which he had raised in a room in his house heated by an ordinary base burner.

Mr. Seddon gave an account of a series of experiments carried out at the St. Louis Water Works on a plan suggested by Col. Flad to determine the relative efficiency of the "flowing water" and "settling basin" systems for clearing the water of sediment.

The result of the experiment showed the efficiency of the former system to be 56 % of the efficiency of the latter.

The Academy listened with great pleasure to addresses by Mr. Winslow, State Geologist, and Mr. R. S. Woodward, of the U. S. Geological Survey, on the work and objects of the Academy.

January 6th, 1890.

President Nipher in the chair; fourteen members present.

Prof. Nipher made a report on the weather of the months of December, January, and February, as derived from the records, begun in 1837, by Dr. Engelmann.

Mr. Wheeler remarked that on recently visiting the Insane Asylum well, he found that the cistern, from the bottom of which the well was drilled, was being used as a steam trap by the engineer, and that the well is at present inaccessible; that the boxes which contained samples of the drillings from the well were left uncovered and unprotected in the basement of the Asylum, and were liable to become seriously impaired, if they were not already worthless, by having got mixed; that no interest or care seemed to be exercised by the officials in charge of the Asylum in preserving the samples, or in preventing the bore-hole from getting filled up with rubbish.

The President read his annual address as follows:

THE PRESIDENT'S ADDRESS.

Gentlemen of the Academy:

It is with a feeling of satisfaction that we may pause for a moment at the close of the year. With each year it is clear that we are slowly advancing towards the position which, from the beginning, has been the aim of the promoters of the Academy.

We are not only out of debt, but, thanks to those who have given us pecuniary aid, we are beginning to enjoy an income from invested funds.

During the past year a bequest of $1,000 has been received from the estate of the late Mr. Henry Shaw.

The publication of the will of Mr. Shaw has revealed the plan which he was slowly maturing in the development of his botanical garden. He founded and endowed a School of Botany as a department of Washington University, and supplemented this act by giving the bulk of his great estate for the perpetual maintenance of the garden and arboretum. It had always been his delight to minister to the pleasure of the public. His gates were always open that others might enjoy the rare and beautiful plants which he had collected. He provides for the perpetual continuation of his policy, and directs that the ornamental and attractive features of the garden shall be maintained. But he does vastly more; he provides for the instruction of garden pupils in practical and scientific horticulture, agriculture, and arboriculture. He declares that scientific investigations in botany proper, in vegetable physiology, the diseases of plants, the study of the forms of vegetable life and of animal life injurious to vegetation, experimental investigations in horticulture and arboriculture, are also to be carried on.

He has founded a great scientific institution, and has clearly defined the broad field which it is to cover; yet he has the rare wisdom to leave the details of instruction to those to whose administration the trust was left, that, as he says, they may shape the particular course of things to the condition of the times.

It is very evident that this trust needs only a prudent and able administration to develop here in onr midst a scientific institution which will be an honor to American science.

As members of the Academy we should, and do, feel a lively interest in the success of this magnificent bequest. We should also feel that in giving the Academy of Science a share in the administration of this trust, by making its President an ex-officio member of the Board of Trustees he has placed upon us a serious responsibility.

As an official acceptance of this trust, I recommend that service upon the Board of Trustees of the Missouri Botanical Garden shall, by amendment to the constitution, be incorporated among the duties of the President.

The establishment of the garden on a sure and lasting basis has had the result of saving for permanent preservation in our midst the valuable herbarium and library of the late Dr. George Engelmann. It is not too much to say that the herbarium, representing as it does the life-work of one, who, as a worker in science, has had few equals in this country, is the crowning glory of the garden. It would have been a serious loss if this collection had been allowed to go elsewhere, or to suffer injury from lack of proper care.

During the year the meetings of the Academy have been regularly held, and many interesting communications have been made. Four have been elected to membership, and two have died. At the close of the year the membership numbers seventy-six.

The report of the Treasurer was referred to an Auditing Committee, and found by them to be correct.

The annual election of officers for the year 1890 resulted as follows:

President—Francis E. Nipher.
1st Vice-President—Jas. M. Leete.
2d Vice-President—M. L. Gray.
Corresponding Secretary—Edward Evers.
Recording Secretary—E. A. Engler.
Treasurer—Enno Sander.
Librarian—G. Hambach.
Curators—{ G. Hambach, Chas. Lüdeking, Jas. A. Seddon.

January 20th, 1890.

President Nipher in the chair; seven members present.

Prof. Nipher made some remarks on recent developments in electricity, with special reference to modern views concerning the theory of the subject.

February 3d, 1890.

President Nipher in the chair; twelve members present.

Prof. Nipher made the following remarks concerning the weather for Jauuary:

The temperature of the January just passed has been 37°.5, which is 6°.3 above the normal for January. It may fairly be called a warm month, but it is by no means the warmest on record, as was the December previous. There have been seven Januaries since 1837 which have been warmer. The warmest on record was January, 1880, which had a mean temperature of 46°.2, or 8°.7 above the mean of the last month, or 15° above the normal.

In 1886 January was very cold, having a temperature of 22°.2. Since then the temperature of January has been continually warmer. The January just passed was warmer than that of 1889 by 3°.4.

So far, the winter as a whole has been abnormally warm, with a marked absence of severe storms over the whole eastern half of the country.

What would it not have been worth if the character of the season could have been predicted! As a matter of fact, the weather prophets who present themselves so obtrusively before the public with their predictions have failed to give any useful prediction of the present weather. We find, on referring to their storm charts, that the planets have been going on with their danger days and storm periods just as before, and yet the weather has paid no attention to them.

The winter, so far, has been sufficiently remarkable to attract the attention of any prophet who can predict. There were only two days in December and there were only eleven days in January when the daily mean was below the freezing point. There have been only fonr days in the whole winter, up to date, when the daily maximum did not rise above the freezing point. We had a tornado on the 12th, when there was nothing in the shape of a planet to produce it.

Vulcan is marked as likely to make trouble on the 5th, 17th, and 28th, and there are no other causes for weather during the entire month; and here came a tornado, without any cause, on the 12th. When could a tornado or storm occur in order to disprove the theory of "planetary equinoxes" if the many storms which occur midway between the predicted dates do not disprove it?

February 17th, 1890.

Vice-President Dr. Leete in the chair; eleven members present.

Discussion on the revision of the Constitution and By-laws.

March 3d, 1890.

President Nipher in the chair; thirteen members present.

Discussion on the revision of the Constitution and By-laws continued.

March 17th, 1890.

President Nipher in the chair; eight members present.

In response to an appeal from the University of Toronto for assistance in forming a new library to replace the one destroyed by fire on the night of the 14th of February, 1890, the librarian was instructed to send a set of the Transactions of the Academy.

Prof. Wheeler presented a paper on "Recent Additions to the Mineralogy of Missouri," in which he gave a list and exhibited specimens of 27 minerals that have been found occurring in Missouri since the publication of Mr. Leonhardt's paper in 1880.

Discussion on the revision of the Constitution and By-laws continued, and new Constitution adopted.

April 7th, 1890.

President Nipher in the chair; eight members present.

Prof. Wheeler gave the results of studies by Dr. Lüdeking and himself on a variety of Barite found near Sedalia, Mo., which presents peculiar crystallographic and chemical properties.

Discussion on the revision of the Constitution and By-laws continued, and new By-laws adopted.

April 21st, 1890.

President Nipher in the chair; six members present.

Dr. Curtman read a paper, illustrated by numerous experiments, on "The Detection of Glucose," in which he gave an illustration and description of all the methods now in use. A vote of thanks was passed.

The Secretary presented, by title, a paper entitled "Flowers and Insects—*Umbelliferæ*," by Charles Robertson of Carlinville, Ill. Referred to the Council.

May 5th, 1890.

President Nipher in the chair; seven members present.

Prof. Wheeler exhibited and described a specimen of Ferro-Goslarite, found by Mr. Thacher in the neighborhood of Joplin, Mo.

May 19th, 1890.

President Nipher in the chair; eleven members present, also several visitors.

Prof. Snow presented to the Academy a framed photograph of Dr. Pasteur, the eminent French biologist, and gave a short account of a visit to the Pasteur Institute, in Paris, during last summer. The photograph was accepted by the Academy, and a vote of thanks to Prof. Snow was passed.

Mr. Arthur Winslow, State Geologist of Missouri, gave a statement of the work now in progress in the Geological Survey of the State, and of plans for future progress of the work.

The Secretary read a communication from Dr. Gustavus Hinrichs, from Iowa City, containing a brief preliminary note on the remarkable meteor of the afternoon of May 5th, and the meteorites which it has scattered over the central part of Winnebago county, north-west of Forest City, Iowa. "The meteor was so bright that it was distinctly seen from Des Moines, over one hundred miles south of its termination. Its cosmical flight came to an end in a tremendous detonation at an elevation of about ten miles; a cloud formed by the detonation remained stationary at this point for some time. Thus far a multitude of small meteors have been found scattered over more than a dozen square miles of Winnebago county. Most of this meteorite field is unbroken prairie land, which fact has interfered with the finding of specimens. The search has been very active, since the specimens are readily sold at $1 an ounce. Few of the specimens weigh over a pound; the largest one thus far found is a splendid specimen 66 pounds in weight and completely coated black. [Photograph enclosed.]

The meteorites of this kind are *Chondrites* [Rose] and *Sporadosideres* [Meunier] containing the nickelferous iron in small particles only, so far as we have been able to see. The specific gravity of a small perfect specimen was found to be 3.65. [Specimens of eleven grammes enclosed.]"

June 2d, 1890.

President Nipher in the chair; eleven members present.

Mr. Letterman offered to make a donation to the Academy of the duplicates of the specimens in his herbarium, which he is just revising. He was requested to make his offer in writing, and the matter was then referred to the Council.

Mr. Nipher made some remarks on the efficiency of an electric-lighting plant. He showed how the indicated horse-power varied with the number of lamps, and how insufficient wiring of a building would affect the indicated horse-power as a function of the number of lamps.

The Secretary read, by title, a paper on "Analysis of the Barium Group," by Dr. C. Lüdeking.

A gift of a large number of medical journals from Dr. Alt was acknowledged by a vote of thanks.

Adjourned until the third Monday in October.

October 20th, 1890.

President Nipher in the chair; thirteen members present, also four visitors.

A gift from Prof. Pritchett of a framed copy of an artotype reproduction of a crayon drawing made from the negatives of the sun's corona taken by the Washington University Eclipse Party at Norman, California, January 1st, 1889, was formally accepted by the President and acknowledged by a vote of thanks.

Mr. A. S. Hitchcock read extracts from his paper entitled "A Catalogue of the *Anthophyta* and *Pteridophyta* of Ames, Iowa." Referred to the Council for publication.

Prof. Nipher read a paper entitled "Surface Integrals in Meteorology," in which the total rainfall over the whole United States in cubic feet per second was given for each month in the year. The values were the means of ten years ending January, 1880. Referred to the Council for publication.

A paper was read by Mr. J. C. Duffey on "Transformations of a Carabid (*Plochionus timidus*), and Observations on three Enemies of the Red Spider." Referred to the Council for publication.

November 3d, 1890.

President Nipher in the chair; eleven members present.

In the absence of the Recording Secretary, Mr. H. A. Wheeler was elected Secretary pro tem.

Prof. Nipher presented a communication on the "Friction of Engines," illustrating his remarks by a model.

Dr. Todd made some observations on an interesting occurrence of the loess near Carson, in St. Louis county.

Dr. Wellington Adams exhibited a special form of milliampère metre designed for the use of physicians.

November 17th, 1890.

President Nipher in the chair; twelve members presen, afso two visitors.

Dr. Hinrichs presented to the Library a number of papers on Molecular Science, published in the proceedings of the American Association for the Advancement of Science, the Academy of Science of Vienna, the Comptes Rendus of the Academy of Science of Paris, and others printed separately; also "The Principles of Chemistry and Molecular Mechanics," of 1874; for which he received a vote of thanks.

Mr. Engler made some remarks concerning the properties of the Cone of Revolution.

Prof. Nipher exhibited and described a Westinghouse Transformer.

Prof. Wheeler exhibited and described some quartz crystals from Hot Springs, Arkansas, which beautifully showed the phenomena of "Ghosts" or "Phantoms"; also a specimen showing bubble inclosures about $\frac{1}{3}$ of an inch in diameter; also a fire-opal from Mexico.

December 1st, 1890.

President Nipher in the chair; twelve members preseut.

Dr. Hinrichs made some remarks on the normal paraffin series of hydro-carbons. He said this series was now known with a sufficient degree of accuracy to warrant him to more fully investigate the general laws of their boiling and fusing points; this he has done, and will present the results at the next meeting.

Prof. Nipher made some remarks on the output of an electric motor. Taking the horse-power, current, and potential of the mains as coördinates, he showed that the power applied to the motor, and the power delivered by the motor, were represented by hyperbolic paraboloids.

December 15th, 1890.

President Nipher in the chair; thirteen members present.

Dr. Hinrichs presented the introduction to his "Contributions to Atom-Mechanics."

Prof. Nipher gave a brief discussion of the proper section for an electric railway conductor, with equal spacing of cars operated in multiple.

January 5th, 1891.

President Nipher in the chair; sixteen members present.

The report of the Nominating Committee showed the election of the following officers for 1891:

President—Francis E. Nipher.
1st Vice-President—G. Baumgarten.
2d Vice-President—M. L. Gray.
Recording Secretary—E. A. Engler.
Corresponding Secretary—Gustavus Hinrichs.
Treasurer—Enno Sander.
Librarian—Gustav Hambach.

Directors—{ Robert Moore, James M. Leete.

Curators—{ Gustav Hambach, E. C. Jewett. A. M. Leslie.

President Nipher then delivered the following address:

Gentlemen of the Academy:

The Academy has now reached its thirty-fifth anniversary, and according to our custom we again pause for a moment to survey the history of another year, and to outline our plans for the year to come.

From a business point of view, we were never before so prosperous. It is within the memory of some of us that the very existence of the Academy depended upon liberal annual contributions from the members. Each year our expenses overran our receipts by amounts which sometimes created grave anxiety among those who were in a position to know the facts, and who desired to maintain the Academy.

It frequently happened that only the President and the two Secretaries were present at meetings.

But, if we consider the scientific work actually accomplished, those were fruitful days. Although the present condition and the future prospects of the Academy are most encouraging, our past history does not suffer in comparison with the present. We cannot yet conceal the vacant places of two great men who left us; Engelmann and Riley we have sorely missed. But we gain strength. We are securing the coöperation of new and valued friends. It should be our aim in the future to interest a great number of intelligent men in our city who are not specially engaged in scientific work. Some years ago it was proposed to give a series of lectures, of semi-popular character, for the benefit of our members and friends, and to invite those who should be our friends to be present. At the time there were many difficulties in the way, and the project was abandoned. The matter has again been suggested, and the circumstances seem more favorable. There are many intelligent men in our city who are not engaged in scientific work who aid us greatly in a financial way. It is believed that such persons would greatly appreciate such a conrse of lectures.

There should be a more effective system of publication adopted than that now employed. I observed that at the annual meeting of January, 1873, it was resolved to publish the Proceedings in 16-page installments, and to publish each paper forthwith when its publication was ordered by the Executive Committee.

I find no record repealing this action, but the plan has never been carried out during the fifteen years over which my membership extends. It would certainly make our Transactions a much more desirable medium of publication if such a method were carried out. We would receive papers which we now lose because their appearance cannot be delayed.

From present indications the next number of the Transactions can be published before the close of the coming year, and it should be closed up as soon as possible.

The printing of Prof. Pritchett's report on the results of the Observations on the Eclipse of January 1st, 1889, will soon begin, and the report will soon be ready for distribution.

The number of members now upon our roll is 80, three having been elected during the year.

The report of the Treasurer shows that we have now on hand $968, which, with the income from annual dues, and the interest on invested funds, will enable us to complete the publication of the current number of our Transactions. Our present income from annual dues is $480, and with the interest on $5,000. loaned, $330, makes a total of $810.

In concluding this brief summary of the condition of the Academy, I beg leave to congratulate you upon the hopeful condition of our affairs, and to thank you most heartily for the many courtesies and favors I have received from the hands of each and every one.

Dr. Gustavus Hinrichs presented Part I. of his Contributions to Atom-Mechanics, entitled "The Stereo-chemical Formula and Moments of Inertia of the Saturated Hydro-Carbon Series, with a Crucial Test of the same."

Dr. Trelease presented a paper by Mr. L. H. Pammel of Ames, Iowa, on "The Minute Structure of the Seed-coats of Euphorbia." Referred to the Council for publication.

January 19th, 1891.

President Nipher in the chair; nine members present.

Dr. Hinrichs presented Part II. of his Contributions to Atom-Mechanics, entitled "The Mechanical Determination of the Atomic Volume of the Normal Saturated Hydro-carbons."

Dr. Hambach presented a paper by Mr. A. W. Vogdes, entitled "*Notes on Palæozoic Crustacea*," No. 1; "*On some New Sedalia Trilobites*"— which was referred to the Council.

February 2d, 1891.

President Nipher in the chair; ten members present.

A paper by Mr. Charles Robertson, of Carlinville, Ills., on "Flowers and Insects—*Asclepiadaceæ* to *Scrophulariaceæ*," was read by title and referred to the Council for publication.

Dr. Hinrichs presented Part III. of his "Contributions to Atom-Mechanics."

February 16th, 1891.

President Nipher in the chair; eleven members present.

Prof. Pritchett read a paper, entitled "An Empirical Formula for Predicting the Population of the United States." Referred to the Council.

Dr. Gustavus Hinrichs presented Part IV. of his "Contributions to Atom-Mechanics."

March 2d, 1891.

President Nipher in the chair; seventeen members present.

Dr. Gustavus Hinrichs presented Part V. of his "Contributions to Atom-Mechanics."

Prof. W. B. Potter presented a communication, illustrated by means of the estereopticon, on "Some Notable Examples of Ancient Disintegration," in which he described and explained the formation of the iron ore deposits at Iron Mountain and Pilot Knob, Missouri.

March 16th, 1891.

President Nipher in the chair; eight members present.

Dr. Hinrichs described "Lippmann's Permanent Photographs in Natural Colors," an account of which is published in the *Comptes Rendus*, February 2, 1891, and in *La Nature*, February 14, 1891.

April 6th, 1891.

President Nipher in the chair; nine members present.

Dr. William Townsend Porter presented a communication on "The Origin of the Dicrotic Elevation in the Arterial Pulse," in which he showed that the time interval between the primary and the dicrotic waves is the same in all arteries of the same individual when curves simultaneously registered are compared.

This result is in accordance with E. H. and Wilhelm Weber's theory of wave transmission in elastic tubes, and is incompatible with a peripheral origin of the dicrotic wave.

April 20th, 1891.

President Nipher in the chair; nine members present.

Dr. Todd exhibited some specimens of *Bombex Cicropia* which he had plucked from trees in the city, and called attention to the fact that they were more numerous this spring in the city than he had ever observed them before in either city or country.

Mr. Seddon discussed the rate of travel of flood-waves down our western rivers, concluding that the rate was the same at high and low stages within the limits of overflow.

May 4th, 1891.

Professor Nipher in the chair; four members present.

Prof. Nipher read a paper on the determination of the maximum output and efficiency of an electric motor, in terms of the current which will flow through the motor when running without load, and the current when the motor is at rest, the terminal potential being held constant.

May 18th, 1891.

President Nipher in the chair; eight members present.

Dr. Wellington Adams presented a "Discussion of the Problem of Mechanically Propelling Road Vehicles," calling attention to the work in this direction in the past, the essential qualifications for success, concluding with an illustration and description of what he considered a practical solution of the problem.

June 1st, 1891.

President Nipher in the chair; fourteen members present.

Prof. Pritchett read a paper on "Observations of the Transit of Mercury," together with an account of the observations made by Mr. O. B. Wheeler. Referred to the Council for publication.

Dr. Hinrichs exhibited a large scale drawing of the recent determinations of G. C. Schmidt [Ztsch. Physikal. Chemie, 1891, pp. 433–467] of the boiling points of six fatty acids under pressure up to one atmosphere.

On motion, the President appointed a committee, consisting of Messrs. Pritchett, Moore, and Leete, to draw up a suitable memorial of the late Judge Samuel M. Breckinridge to be submitted to the Council, and, if approved by them, a copy to be sent to the family of Judge Breckinridge, and to be reported to the Academy in the fall.

Adjourned until the third Monday in October.

October 19th, 1891.

President Nipher in the chair; seventeen members present, also Prof. E. S. Morse of Salem, Mass.

The Secretary reported that, in acordance with instructions from the Academy, the committee appointed to draft a suitable expression of the sense of the Academy in relation to the death of Judge Samuel M. Breckinridge, had submitted their report to the Council, and that a copy of the same had been sent to the family of Judge Breckinridge.

The report was as follows:

To the Academy of Science of St. Louis.

Your committee. appointed to prepare a statement expressive of the sense of the Academy relative to the loss which it has just sustained in the death of Judge Samuel M. Breckinridge, beg to report as follows:

In the death of Samuel M. Breckinridge, for more than fifteen years a member of the Academy of Science of St. Louis, this Academy has lost a steadfast friend of Science. Himself a student in his own profession, and deeply interested in all lines of scientific research, his influence in this Academy has been always given toward the encouragement of scientific progress in St. Louis.

Among the members of this Academy who are active workers in Science, there are few who have not cause to remember gratefully his constant and generous interest, during all these years, in all that looked toward the building up of scientific enterprises in St. Louis, and who have not felt the encouragement of his hopeful spirit and the stimulus of his warm-hearted sympathy.

In the Academy of Science, as in his professional and social life, his hopefulness has been a constant support to his fellow-workers in the midst of difficulties, and a never-failing inspiration for the future. His was one of those buoyant spirits whom adversity does not depress, and who always looked beyond the difficulties of to-day to the triumph of to-morrow.

In his death the Academy has lost a wise counsellor and a sincere friend. Deeply conscious of the loss which has befallen our own association, and the yet wider circles of influence in this community in which he moved, the members of this Academy would extend to his sorrowing family the earnest assurance of their deepest sympathy— a sympathy such as those only can offer who share a common loss and common sorrow.

Respectfully submitted,

]Signed,] H. S. Pritchett,
Robert Moore,
James M· Leete.

Committee.

A reply expressing the appreciation of the family of Judge Breckinridge was read by the Secretary.

Dr. W. Townsend Porter exhibited an apparatus for the administration of ether and chloroform to tracheotomized animals during artificial respiration. The device consisted of a respiration-flask inserted in the course of the tube leading from the bellows to the tracheal canula. The flask is of two litres capacity, and has three necks. Two of these are furnished with wide glass tubes, *A* and *B*, of such a length that the air entering through *A* must stream along the floor of the flask in order to reach the exit-tube *B*. The middle neck is fitted with a small separating-funnel provided with the usual ground-glass cock and stopper. The funnel is filled about three-fourths full with the ether-chloroform mixture, and the stopper replaced. During artificial inspiration the pressure in the flask is increased and bubbles of air pass up the funnel-tube, but the ground-glass stopper prevents the ether from being driven out. During expiration the pressure in the flask rapidly sinks, and one or more drops of the anæsthetic fall through the funnel-tube. The number of drops, and consequently the degree of saturation of the inspired air, can be regulated by turning the stop-cock.

Prof. Nipher read a paper on "Certain Properties of a Field of Force due to a Single Mass."

The paper was referred to the Council for publication.

Mr. H. J. Webber presented by title a "Catalogue of the Flora of Nebraska," and gave a short statement of the purpose and contents of the catalogue. This contribution was referred to the Council for publication.

On the invitation of the President, Prof. E. S. Morse of Salem, Mass., favored the Academy with some remarks on the Evolution of the Bow.

November 2d, 1891.

President Nipher in the chair; sixteen members present.

Dr. Trelease read a paper entitled "The Object of the Botanical Movement in St. Louis," in which he outlined the field of botanical research, and indicated some of the ways in which the Botanical Garden and School of Botany, established by the late

Henry Shaw, might be made to contribute to a useful advancement of the science of botany.

Dr. Hinrichs presented a paper on "The Determination of the Magnetic Rotary Polarization of Compounds from their Chemical Formulæ."

A paper by Dr. H. H. Behr, of San Francisco, entitled "Some Biological Peculiarities of the Phylloxera, and a Method to Utilize them for the Protection of Vineyards," was read by Dr. Trelease.

November 16, 1891.

President Nipher in the chair; nine members present, one visitor.

Prof. Nipher exhibited drawings for Electric Railway Power Stations of the Edison and Thomson-Houston systems, and explained the arrangement and uses of the various machinery employed, and the manner of its operation.

Mr. Winslow made some remarks on the progress of work in the Geological Survey of the State.

December 7th, 1891.

President Nipher in the chair; fourteen members preesnt.

A donation from Dr. Gustavus Hinrichs of a pamphlet entitled "A Celestial Messenger, or Fiery Stones hurled from Heaven," being a reprint of a paper contributed by him to the *Chaperone* (St. Louis), and of a collection of "Six Notes de Chimie Moleculaire," contributed by him to the *Comptes Rendus* (Paris), T. cxii. and cxiii. 1891, was acknowledged by a vote of thauks.

Prof. Pritchett gave the results of the discussion of observations made during the past winter for the determination of the Rotation Period of Jupiter. The object whose transits across the centre of the disc were observed was the well known "Red Spot" which has been a permanent feature of the planet for 13 years.

From 21 equations of condition there was found

$$\text{Rotation time} = 9^h\ 55^m\ 37^s.37 \pm 0^s.38.$$

This spot has been observed to rotate for some years past in $9^h\ 55^m\ 42^s$, and the result just given is particularly interesting as showing that the spot has resumed its drift in the direction of the rotation, or has at least slackened its drift in the opposite direction.

The spot will be observed during the present opposition when a full discussion of the observations of both years will be presented.

Mr. Seddon gave as his conclusion for a resistance formula for river flow—

$$R = A V \tan \varsigma \; dL.$$

where

R = the energy in foot-pounds per second expended in flow through the distance, dL.

A = the water area of the cross-section.

V = the mean velocity in feet per second.

and ς = a mean angle of instantaneous divergence of particles from the direction of the mean stream lines.

or $V \tan \varsigma$ = a mean velocity of circulation at the section.

Prof. Wheeler exhibited a live cray-fish which he had found on Nov. 26, 1891, at a depth of 5 feet in very solid dry clay on West Pine st., near Forest Park (St. Louis), on the site of an old swamp. It was dormant when first unearthed, and a continuous hole extended from it to the surface.

December 21st, 1891.

President Nipher in the chair; fifteen members present.

Prof. Nipher read a note on the Rotary Polarization of Light in Hydro-carbon Serial compounds.

The object of the paper was to show a method of determining the relative dimensions of the molecules of such Serial compounds.

EDMUND A. ENGLER.
Recording Secretary.

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Fig. I.

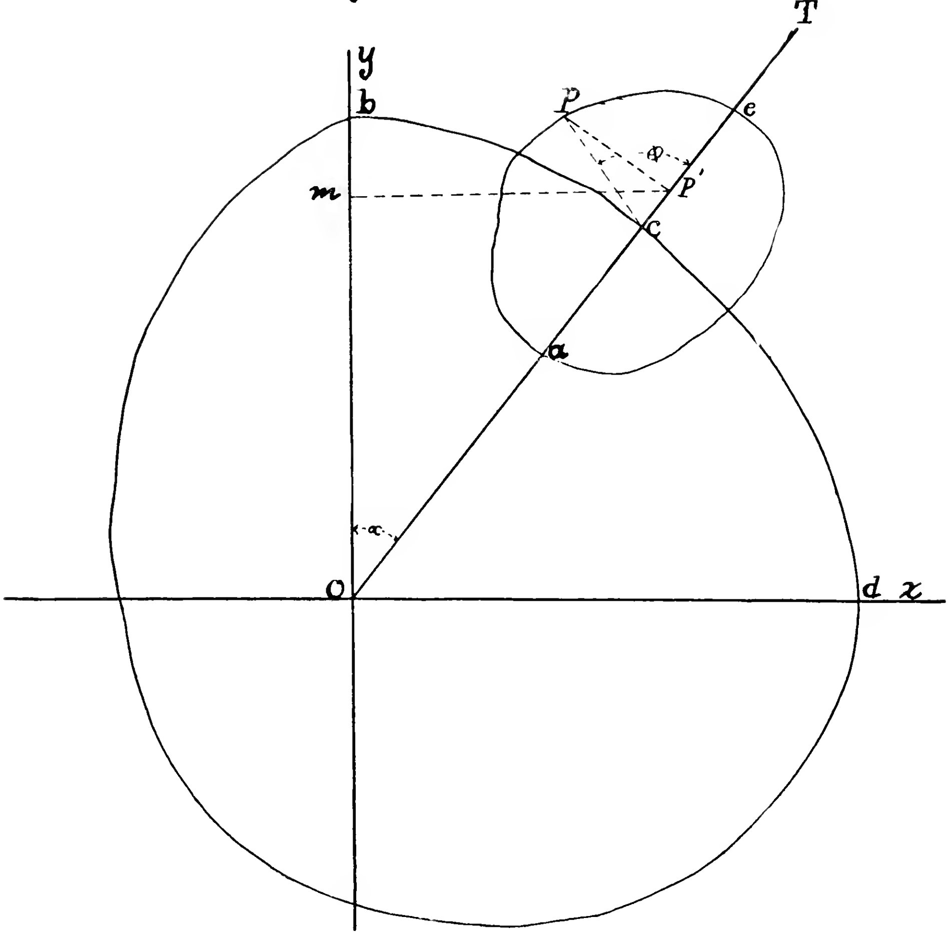
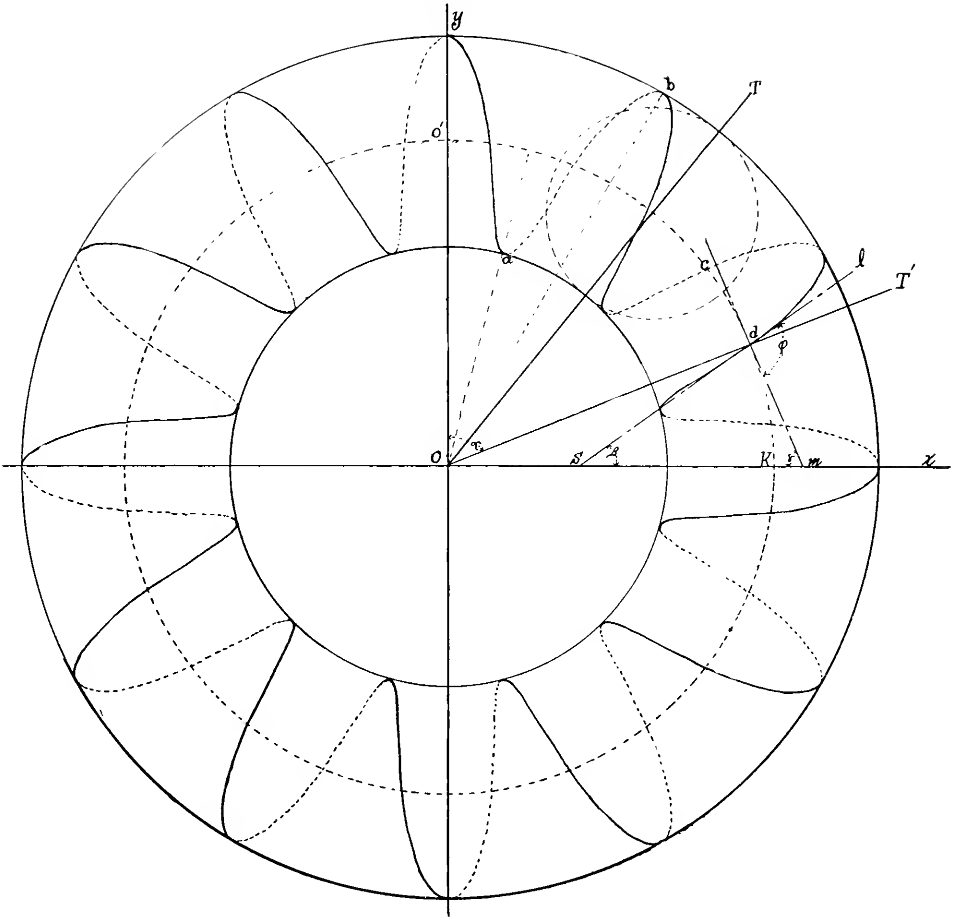
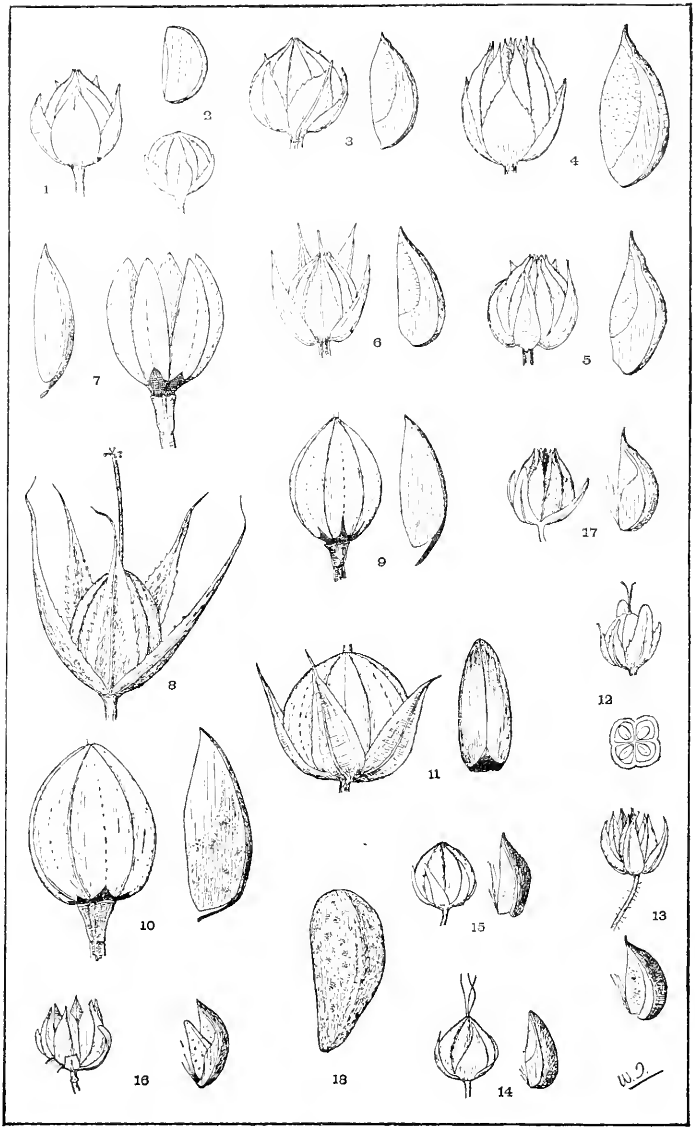
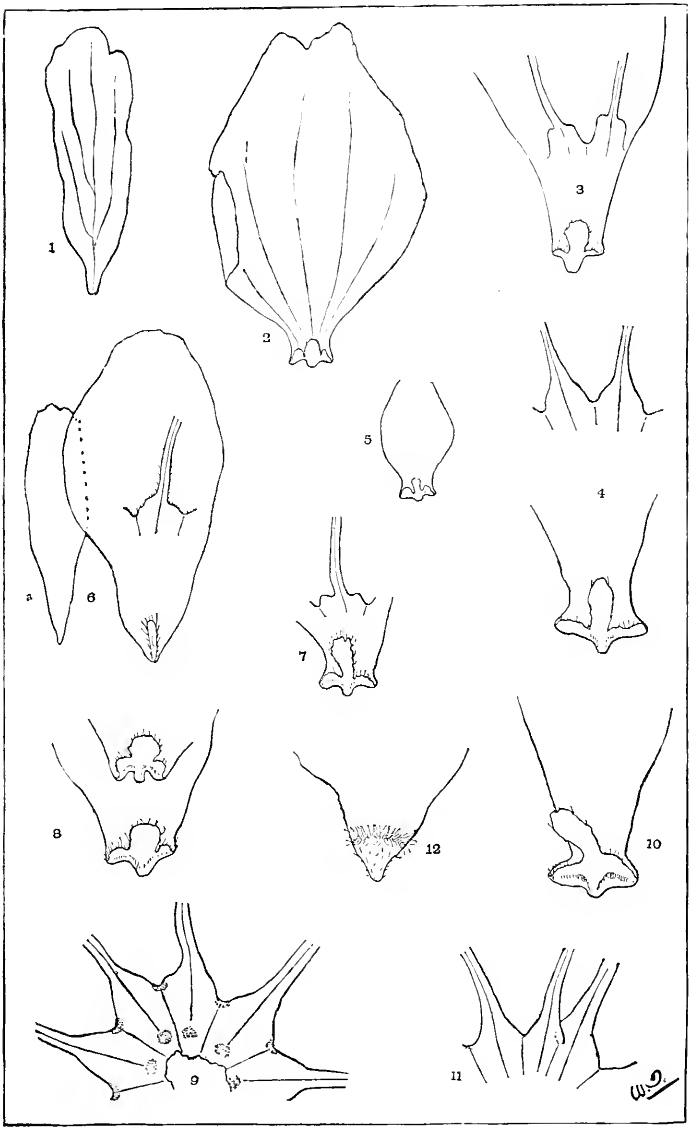


Fig. II.





Fruit of Linum.



PETALS AND FILAMENTS OF HESPEROLINON.

Fig. 1

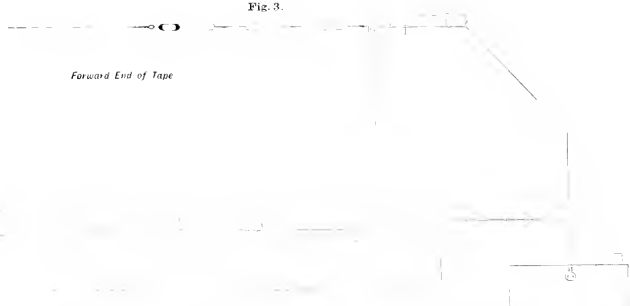
ELEVATION.

Rear End of Tape

Fig. 2.

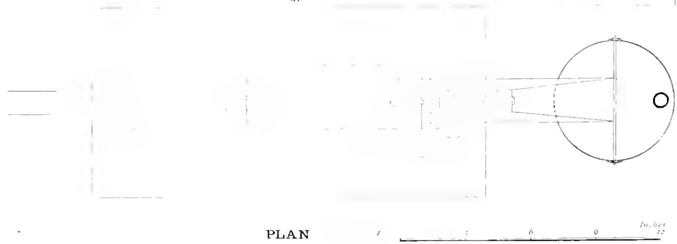
PLAN

Fig. 3.



ELEVATION

Fig. 4



PLAN

ADJUSTER (SECONDARY BASE APPARATUS).

EXPLANATION OF PLATE VI.

Phlomis tuberosa.

Fig. 1. A flower somewhat enlarged. *st.*, stamens; *s.*, style; *k.*, keel, and below this the inflated portion of the corolla.

Fig. 2. A flower with the upper lip turned back. *st.*, stamens; *s.*, style; *b.*, bracts.

Fig. 3. A flowering branch, natural size.

Fig. 4. Style and stigmas somewhat enlarged.

Fig. 5. Longitudinal section of flower. *o.*, ovary; *s.*, style; *g.*, ring of hairs and bulging of corolla at this point; *n.*, nectary; *c.*, calyx lobes; *a.*, point of attachment of shorter pair of stamens; *a'.*, hooked appendages of the filaments of the longer pair of stamens.

Fig. 6. Cross-section of tube of corolla at enlargement, showing the hairs projecting in.

Fig. 7. Pollen grains magnified 120 diameters.

Fig. 8. Receptacle and the lobed nectar g'and, *gl.*; *o.*, nutlets, the style coming up in the centre

EXPLANATION OF PLATE VII.

Perforations.

Fig. 1. *Gentiana asclepiadea*, *L.*—Müller, Alpenblumen, p. 336.

Fig. 2. *Arctostaphylos officinalis*, Winn & Grab.—Müller, l. c. 386.

Fig. 3. *Aconitum Napellus*, *L.*—Müller., l. c. 137.

Fig. 4. *Aconitum Lycoctonum*, *L.* *a.*, long-spurred form; *b.*, short-spurred form.—Aurivillius, Bot. Centralblatt, vol. xxv. p. 125.

Fig. 5 *Centrosema Virginiana*, Benth.—Trelease, Am. Naturalist, 1879, p. 690.

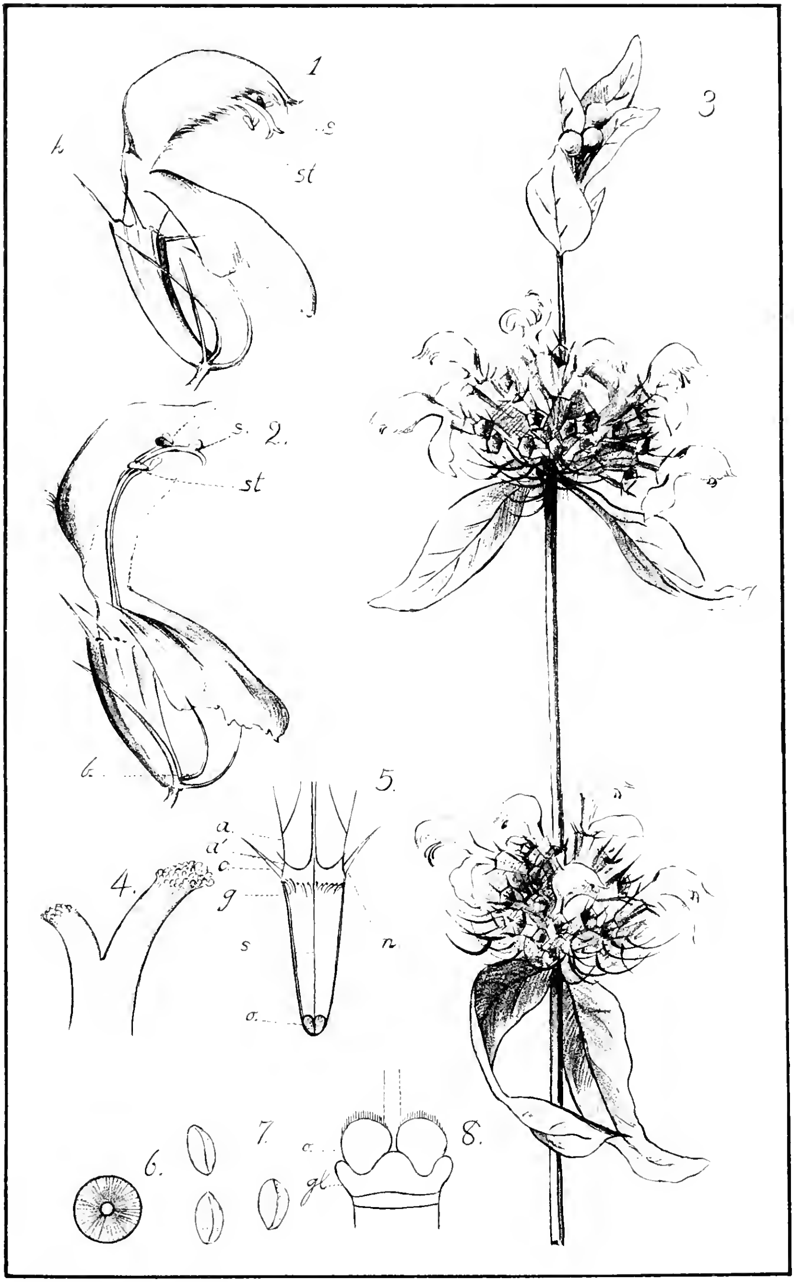
Fig. 6. *Gaylusaccia dumosa*, var. *hirtella*, Gray. *a.*, the small perforation in flowers just opened.

Fig. 7. *Impatiens fulva*, Nutt. After sketches made by Prof. Trelease, showing the way in which honey-bees obtain nectar through perforations.

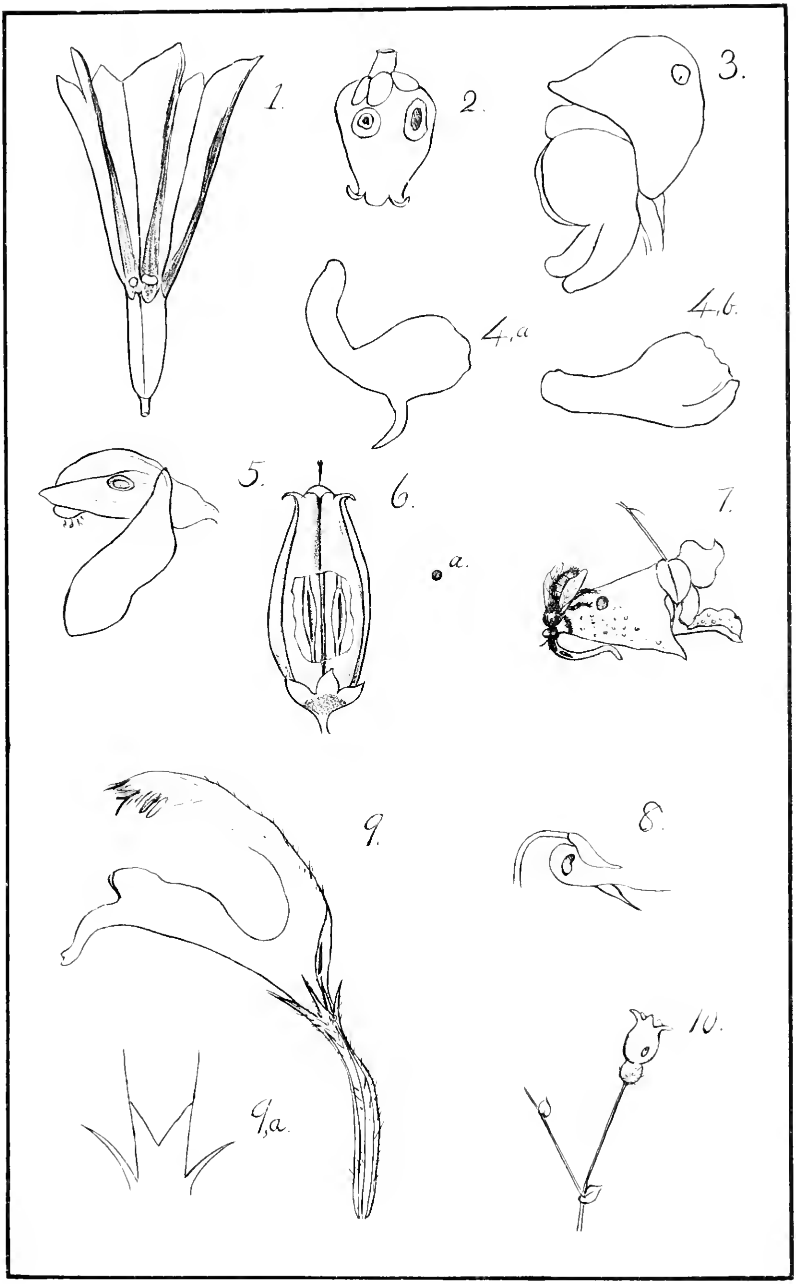
Fig. 8. *Viola palmata*, var. *cucullata*, Gray.—Sketch by Prof. Trelease, showing perforations in spur

Fig. 9. *Monarda Bradburiana*, Beck. The slit is shown on the upper side of the tube of the corolla. *a.*, the triangular cut in tube, described by Mr. Robertson.

Fig. 10. *Ribes Cynosbati*, *L.* Perforation in calyx.



L.H.Pammel & M.H.Hoke del.


1.
2.
3.
4,a
4,b.
5.
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a.
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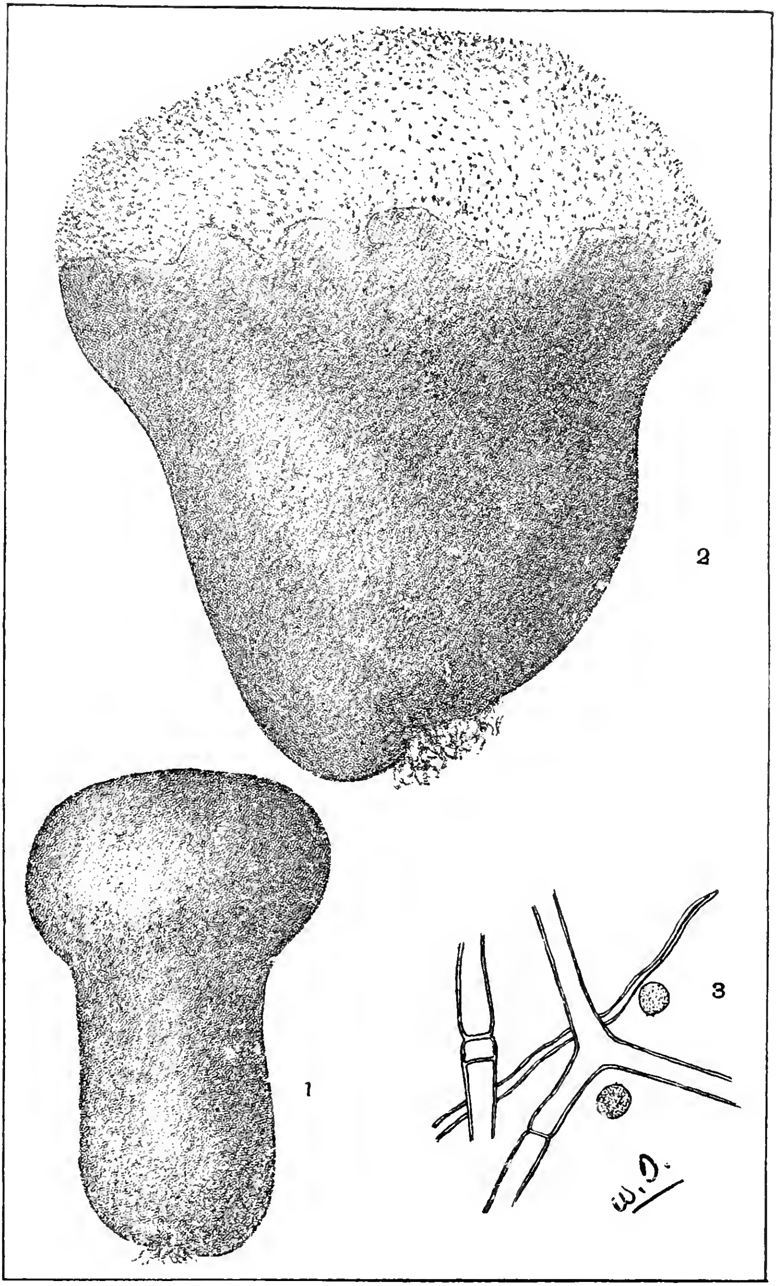

LYCOPERDON MISSOURIENSE.

Explanation of Plate.— Fig. :, half-grown plant; fig. 2, mature plant—both of the natural size. Fig. 3, spores and fragments of capillitium, × 1200.

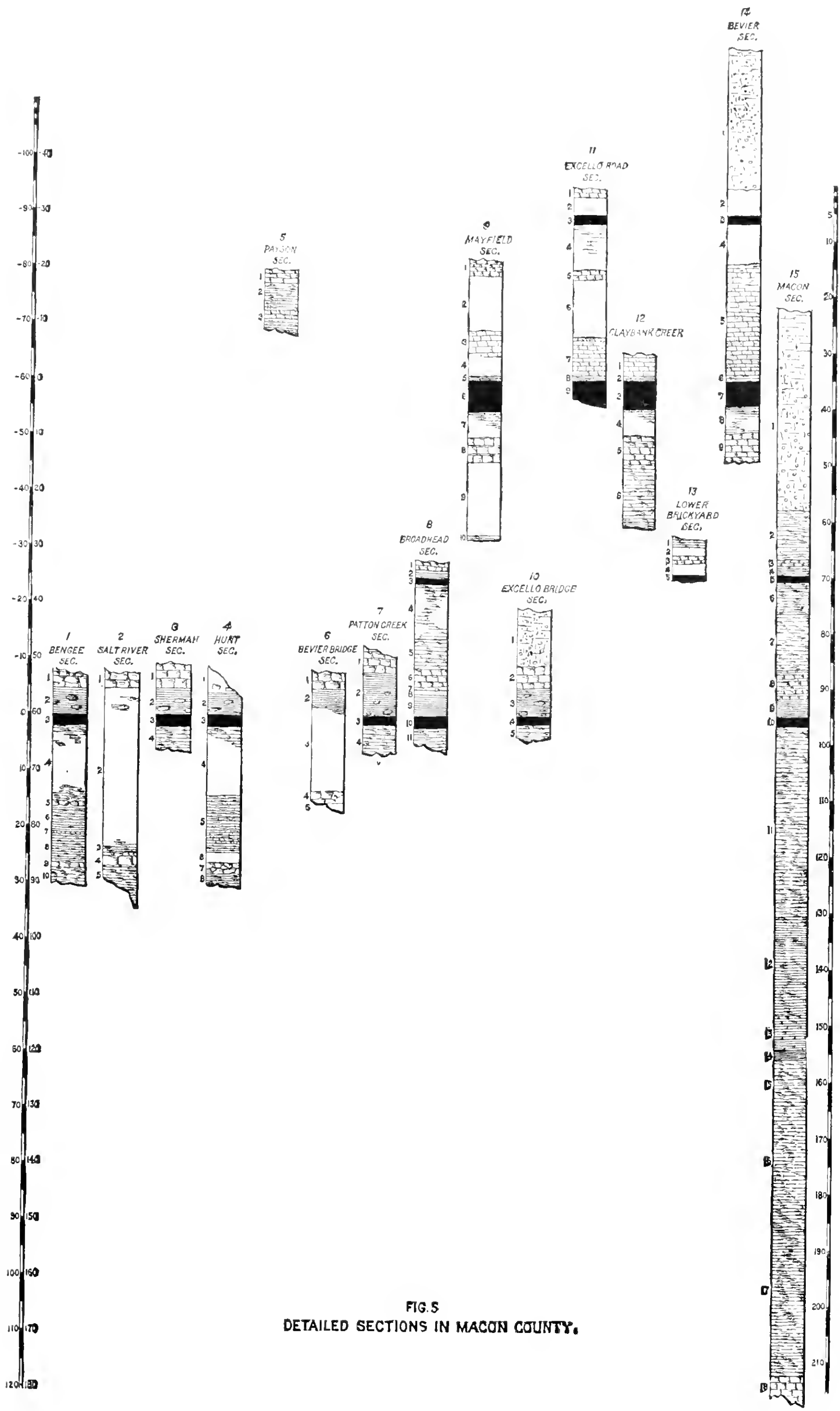

FIG. 5
DETAILED SECTIONS IN MACON COUNTY.

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Jan. 7. 1889

THE

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