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TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS AND LETTERS

EDITED BY THE SECRETARY

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ON SOME FORMAL ANALOGIES

BETWEEN

THE PARTIAL DIFFERENTIAL EQUATIONS

Expressive of the strains in a circular elastic plate under certain distributions of load, and the equations which give the magnetic force in a cylindrical iron core under the influence of electrical current; together with some other formal electric and elastic analogies.

BY

JOHN E. DAVIES,

Professor of Mathematical Physics in the University of Wisconsin.

ON SOME ANALOGIES BETWEEN THE EQUATIONS OF ELASTICITY AND ELECTRO-MAGNETISM.

By JOHN E. DAVIES,

Professor of Physics in the University of Wisconsin.

The whole tendency of experimental work in electricity and magnetism since Clerk Maxwell's celebrated working-out of the stresses and strains in a dielectric medium subjected to electric or magnetic forces, has been to confirm the reality of the existence of such states of stress.

The work of Hertz, Lodge, Thompson, Tesla and many others, points certainly in this direction. One cannot take up a modern treatise on elasticity in which the lines of stress of a strained elastic medium are shown without being struck with the resemblance of these lines to those of electro-static or electro-magnetic induction across dielectrics connecting conductors or magnetized bodies.

To the mathematican the analogies presented by the analytical formulæ are numerous and striking. Especially is this true of some of the differential equations which present themselves in the theories of elasticity and of electro-statics. But it is also true of many of the equations peculiar to electro-magnetism. Some of these formal analogies have already been alluded to by Sir Wm. Thomson* and Oliver Heaviside — especially the latter.

* From a remark of Sir William Thomson in his presidential address before the Institution of Electrical Engineers, January 10th, 1889, entitled, "Ether Electricity and Ponderable Matter," it would appear that Faraday had set forth a theory of electro-statical induction, which suggests the idea that there may be a problem in the theory of elastic solids corresponding to every problem connected with the distribution of electricity on conductors, or with the forces of attraction and repulsion exercised by electrified bodies. Sir William adds "the clue to a similar representation of magnetic and galvanic forces is afforded by Mr. Faraday's recent discovery of the affection with reference to polarized light of transparent solids subjected to magnetic or electro-magnetic forces. I have thus been led to find three distinct particular solutions of the equations of equilibrium of an elastic solid, of which one expresses a state of distortion, such that the absolute displacement of a particle in any part of the solid represents the resultant attraction at this point produced by an electrified body. Another gives a state of the

I have in each case indicated the sources from whence the formulæ are derived as well as the general course of the demonstrations by which their authors have established them. I have done so partly for the purpose of showing the entirely distinct grounds upon which the demonstrations are based in the two theories, and consequently the greater impressiveness and possible meaning of their coincident results, and partly in order to call the attention of elementary students of both subjects to a field which seems to be one of considerable promise. It seems certain that in this great border region of the elastic and other mechanical properties of a medium in which ether, matter, and possibly a "*tertium quid*, electricity" exist, lie some of the greatest problems and discoveries of the near future in both chemistry and physics. It is that towards which Sir Wm. Thomson, in his Baltimore lectures and various papers published since then, has contributed so largely, and in which the efforts now making to find a comprehensive theory of physical optics have been so ably summarized by Prof. Glazebrook in his Report to the British Association for the Advancement of Science (Aberdeen meeting, 1885). It is the complete theory of the ether embracing electro-magnetism and optics, towards which our present knowledge has made only a small advance.

These close analogies between elasticity and electro-statics or magnetism have led me to place side by side a few of the well known formulæ of both of these great fundamental branches of physics, with their derivations. In this manner the points of resemblance become more ap-

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solid in which each element has a certain resultant angular displacement, representing in magnitude and direction the force at this point produced by a magnetic body; and the third represents in a similar manner the forces produced by any portion of a galvanic wire; the directions of the force in the latter case being given by the axis of the resultant rotations impressed upon the elements of the solid."

"Let there be an elastic body of exceedingly small density, and let there be a tubular portion of it porous, but with the same aggregate rigidity as that of the continuous elastic matter round it. Let the pores be filled with a dense viscous fluid, and let this fluid be forced, by aid of a piston or otherwise, to move through the tube. The pull of the fluid upon the porous solid will produce static rotational displacement exactly proportional to the continued rotatory motion which we had in the case of the viscous fluid. Some of the most interesting practical problems of electro-magnetic induction can be dynamatically realized, as it were, in model, by following out this idea; in fact, if we had nothing but electricity and ether, the thing would be done. If it were not gross ponderable matter that we are forced to consider, I should be perfectly satisfied with the problem of electro-magnetic induction, by taking the electricity as a viscous fluid, and ether an elastic solid, porous in some places, and continuous or non-porous elsewhere." See in particular article XCIV., Reprint of Mathematical and Physical Papers, Vol. III.

parent, and their physical significance, should there be any, are more likely to be understood. Mere analytical or formal analogies may be of some help, and it is only to two or three of these that attention is called in this paper. The first is that of an elastic bent circular plate, and it is compared with an iron core under magnetic force.

It is shown in treatises on elasticity and mathematical physics that in the "case of a uniform plate of finite or infinite extent, symmetrically influenced in concentric circles by a load distributed symmetrically and by boundary appliances if required," if r and θ be polar coördinates of any point P, so that $x=r\cos\theta$ and $y=r\sin\theta$, the origin being at the center of symmetry, then the usual differential equation for the bending of an elastic plate having equal flexibility in all directions, viz.:

$$(1)\ldots\; A\left(\frac{d^4z}{dz^4}+2\frac{d^4z}{dx^2dy^2}+\frac{d^4z}{dy^4}\right)=Z-\frac{dM}{dx}-\frac{dL}{dy}=A\left(\frac{d^2}{dx^2}+\frac{d^2}{dy^2}\right)^2 Z\,*$$

takes the form

$$(2)\ldots\; \frac{A}{r}\frac{d}{dr}\left\{r\frac{d}{dr}\left[\frac{1}{r}\frac{d}{dr}\left(r\frac{dz}{dr}\right)\right]\right\}=Z$$

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* Derived from the more general equation

$$A\frac{d^4z}{dx^4}+2b\frac{d^4z}{dx^3dy}+(C+2c)\frac{d^4z}{dx^2dy^2}+2a\frac{d^4z}{dxdy^3}+B\frac{d^4z}{dy^4}=Z-\frac{dM}{dx}-\frac{dL}{dy}$$

(where A, b, C, c B, a, are supposed constant and not as in the most general case functions of x and y) on the supposition that all the coefficients of elasticity are equal to any one of them, say A. As to the meaning of the constant A it is

$$=\frac{(1+\sigma)\rho\tau}{\Sigma}.$$

In this expression σ is Poisson's ratio $=-\frac{f}{e}=$ ratio of lateral contraction to longitudinal extension, which is also

$$=\frac{2(2k+n)}{3k-2n}=\frac{m-n}{2m}$$

where k is the bulk modulus and n is the rigidity. σ according to Poisson is always equal $\frac{1}{4}$.† In very many known solids k is greater than $\frac{5}{3}n$, while in others it is less, so that there seems to be no necessary relation between these two constants.

$$\Sigma=\frac{q\tau^3}{12(1-\sigma)}$$

where q is Young's modulus

$$=\frac{3kn}{m}=\frac{9kn}{3k+n}$$

and τ is the thickness of the plate, and ρ its density.

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† Poisson and Navier's assumption that this ratio was always $=\frac{1}{4}$ leads to the constant ratio $\frac{k}{n}=\frac{5}{3}$. Poisson always maintained that the

This is the equivalent of $A\nabla^2\nabla^2 z=Z$; or in other words the Laplacian operator doubly applied, because

$$\nabla^2 z=\frac{1}{r}\frac{d}{dr}\left(r\frac{dz}{dr}\right)$$

where z is a function of r alone (where as usual ∇^2 denotes Laplace's operator), and because the quantity

$$Z-\frac{dM}{dx}-\frac{dL}{dy}$$

becomes, in the case of concentric load, a simple function of the radius

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ratio of k to n is constant and equal to $\frac{5}{3}$. The whole question of the values of these constants and whether there are ultimately one or more in isotropic bodies seems to rest upon whether elastic isotropic bodies can be considered as made up of molecules mutually acting on each other in the line of their centers and according to a law of variation with distance merely, or whether the action of one molecule upon another is likewise a function of the action of other molecules upon each of the two considered—a function of aspect in other words as well as distance. It would seem that this must be true for magnetized bodies where polarity must be considered.

To see that this is so we have only to consider the different expressions for the law of force between two magnets, according as they are *end-on* or *broadside-on* to each other. The expression in either case is a series, involving increasing negative powers of the distance. But this series is in the case of end-on, double its value for the other case, regarding one of the magnets as movable and the other as fixed. It would be an interesting problem to form for a magnetic medium the equations of equilibrium and motion on the hypothesis that we have in such a medium an infinite assemblage of molecules having polarity; in other words an infinite assemblage of molecular magnets whose resultant attractions for each other would be represented by a function of distance and aspect (orientation) and not of distance alone. Green in his remarkable essay on the "Equilibrium of Fluids analogous to the Electrical Fluid," has treated the case of equilibrium of a medium somewhat analogous to such a medium, inasmuch as he applies the method of potentials to the case of a medium where the law of force is inversly as *any* power n of the distance, where n may represent any number whatever, fractional or irrational. On supposing that n is, as in the case of finite magnets sufficiently close to each other to involve a consideration of their lengths and orientation as well as their distances, a complex function of the molecular magnetic moments and distances, all of Green's results would be immediately available to the consideration of any equilibrium problems of the medium which Ewing regards as making up a magnetic one. No doubt the problem of motion would be a complicated one, but it is easy to see without any mathematics that such a medium would possess most of the properties which Ewing has assigned to it in his theory of magnetism.* Green, it is true, conceives

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* An interesting illustration by experiment of such a medium is given by Mr. Crew in the New York Electrical World for 1891. It was also given by Prof. Ewing before the British Association.

of the plate which we may designate by Z. "Z will then be the amount of load per unit area, when the applied forces on each small part are reducible to a single normal force through some point of it."

Small z is then a function of r likewise and denotes the displacement perpendicular to the original plane of the plate. Its value as is well known is:

$$z=\frac{1}{A}\int\frac{dr}{r}\int rdr\int\frac{dr}{r}\int r\,Z\,dr+\tfrac{1}{4}C(\log r-1)\,r^2+\tfrac{1}{4}C'r^2+C''\log r+C'''$$

C''' is merely displacement of the plate as a whole and need not be any further considered.

$C''\log r$ denotes anticlastic displacement with $\pm C''/r^2$ for the curvature, the same in the two principal sections. The radial and cross radial bending couples to match are

$$L=\pm(A-C)\frac{C''}{r^2}.$$

C, the same. This would be realized in an infinite plane plate with a circular aperture and uniform distribution of load in the shape of bending couple around the circular edge everywhere as axis.

$\frac{1}{4}C'r^2$ is the displacement of spherical curvature.

$\frac{1}{4}C(\log r-1)\,r^2$ is a deflection involving shearing force and couple. $-AC/r=$ shearing force and $\frac{1}{2}C(A+c)\log r+\frac{1}{2}(A-C)=$ bending couple.

Since from the symmetry of the case considered when the plate has a circular contour the tangent plane to the strained plate at the center will be horizontal, C'' will be zero unless there be discontinuity in the circular loading so as to cause a circle of inflexion to occur between the center and the outer margin, which is without the limits of any case save a circular loaded membrane and not an elastic plate. It is realized, however, in the case of a plate with a circular aperture.*

If we turn from elasticity to electro-magnetism and consider the induction of currents and magnetic lines in cores under the influence of coils wrapped about them and carrying currents, we shall eventually come upon an equation entirely similar to equation (2). For, as Oliver Heaviside has shown in discussing this subject of induction of currents

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"a fluid analogous to the electric fluid" having only a repulsion between its particles and having moreover V, the potential, only a function of the distances between these particles. But our medium would have to be one in which every particle would have both attraction and repulsion for its neighbors according to the poles presented, and ultimately a repulsion according to an unknown law to account for first the extension of a bar of soft iron under medium magnetic stress, as first shown by Joule and as measured by Mayer and others, and afterwards a contraction, as Shelford Bidwell has shown.

* Thomson and Tait Nat. Phil., §651.

and lines of magnetic force in cores, if we have produced in the core a magnetic force represented by H, and an electro-motive force per unit length at distance r from the axis of the core represented by e, giving rise to a current of density γ (using the square of the same unit of length for the unit area) at the distance r, then H is parallel to the axis and a function of r, γ is a function of r and is perpendicular to r and to H; and since a tube of thickness dr and unit of length must carry a current γdr, and produce a magnetic force in the core of $4\pi\gamma dr$ *within* the current tube, and zero *without*, $4\pi\gamma dr$ is the amount by which H *decreases* in passing from within outwards over a distance from r to $r+dr$. The relation thus established between the induced core current and core force is:

$$\gamma = -\frac{1}{4\pi}\cdot\frac{dH}{dr}\left(= -\frac{1}{4\pi}H' \text{ for short.}\right)$$

This is a special case of Maxwell's $4\pi\gamma =$ Curl H. (See 2d vol. Elec. and Mag.) If ρ denote specific resistance

$$e = \rho\gamma = -\frac{\rho H'}{4\pi}.$$

The core is supposed to be symmetrically situated with respect to the center of the surrounding coil.

The magnetic induction (total) through a core of radius r is equal to

$$\mu\int_0^r H.\ 2\pi r.\ dr$$

and as the electro-motive force is e and its line integral $2\pi r.e$ this must equal the time rate of decrease of the definite integral just given, i. e.,

$$2\pi r e = -\mu\int_0^r \dot{H}.\ 2\pi r dr$$

If in this the value of

$$e = -\frac{\rho}{4\pi}H'$$

above be substituted we will have one form of the differential equation of the magnetic force viz:

$$rH' = \frac{4\pi}{\rho}\int_0^r \dot{H}\mu r dr,$$

the dot denoting a fluxion and the prime mark differentiation to r. Differentiating this equation to r we get

$$\frac{1}{r}\ \frac{d}{dr}(rH') = \frac{4\pi\mu}{\rho}\ \dot{H}$$

a partial differential equation which is a well known special case of the more general one given further on as equation (3).*

*See Fourier's Analytical Theory of Heat; Rieman's Partial Diff. Eqs.; Rayleigh on Sound; Maxwell Elec. and Mag.; Induction of Currents in Cores, Oliver Heaviside, London "Electrician," Vol. X., etc.; etc.)

If the currents in the coil be oscillatory, kept up by an impressed E. M. F.$=E\sin pt$ where $p=2\pi n$ (n denoting the frequency), then the magnetic force in the core will also be oscillatory; and calling it H, we will have also $H=H_1 \sin pt+H_2 \cos pt$.†

If this value of H be substituted in the general differential equation for H just above given, we shall have the two equations:

$$\frac{1}{r}\frac{d}{dr}(rH'_1)=-xH_2$$

and

$$\frac{1}{r}\frac{d}{dr}(rH'_2)=+xH_1$$

where x is put for $\frac{4\pi\mu p}{\rho}$. From these two equations we infer that the common equation which both H_1 and H_2 will satisfy is

$$\frac{1}{r}\frac{d}{dr}r\frac{d}{dr}\frac{1}{r}\frac{d}{dr}r\frac{d}{dr}H=-x^2H \quad .\ .\ .\ .\ (3)$$

This is an equation of exactly the same form as the elastic equation (2).

If H_1 be made equal to A_0M+A_2N where M and N are functions of r and equal to

$$M=1-\frac{x^2r^4}{2^24^2}+\frac{x^4r^8}{2^24^26^28^2}-\frac{x^6r^{12}}{2^2.\ .\ .\ .\ 12^2}+\ .\ .\ .\ .$$

$$N=\frac{xr^2}{2^2}\ \frac{2^24^26^2}{x^3r^6}+\frac{x^52^{10}}{2^2.\ .\ .\ .\ 10^2}-\ .\ .\ .\ .\ .$$

then $H=(AM+BN)\sin nt+(AN—BM)\cos nt$.

If $H_2=B_0M+B_2N$ and $A_0=-B_2$ while $A_2=-B_0$

This can be shown by writing H_1 and H_2 in series, viz.:

$$H_1=A_0+A_1r+A_2r^2+\text{etc.}$$

$$H_2=B_0+B_1r+B_2r^2+\text{etc.}$$

inserting the series in the biquadratic differential equations, as values of H_1 or H_2, differentiating as required and equating to zero the coefficients of the different powers of r. All the odd coefficients A and B disappear. We need only the A_0 and A_2 B_0 and B_2. To satisfy

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† Fleming calls p the *pulsations* of the current; in harmonic motion $p=\frac{d}{dt}=$ a constant.

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the separate equations which give rise to the biquadratic A_o must $=-B_2$ and $A_2=-B_o$ then the expression $H=H_1 \sin nt+H_2 \cos nt$ will take the form $H=(AM+BN) \sin nt+(AN-BM) \cos nt$, as given above.

$$M-Ni=J_o(r\sqrt{xi})$$

$$M+Ni=J_o(r\sqrt{-xi})$$

J_o is the Bessel Function of zero order.

$(H)^2=(A^2+B^2)(M^2+N^2)=(4\pi N)^2(\Gamma)^2$ if Γ is coil current, and N is turns per unit length of core, and parentheses denote average amplitudes of current and force.*

It will be noticed that the magnetic force is a function of r, and that on the right side of the equation we have this force multiplied by $-x^2$. This requires that z in the elastic problem should stand for H in the magnetic one, and that the load per unit area, Z, in the elastic problem should be a multiple of z the displacement. Again, one is positive, the other negative. The one would seem to imply a greater effect the further we go from the center of the core, the other the nearer we go to the center of the plate.

What may be the physical meaning of this analogy, if any, I do not know. The mere fact of the appearance of oscillatory functions to denote results of analysis does not by any means imply the necessary existence of vibrations. The same equation is often satisfied by an expression which denotes a variety of things in physics—witness the celebrated equation of Laplace in partial differential coefficients $\nabla^2=O$ and others. It may be that the analogy is merely formal or mathematical and without any physical significance whatever. It is somewhat singular, however, that the equation is one closely related to waves, and that certainly waves of magnetic force penetrate into the interior of iron cores surrounded by currents, very much after the manner which Fourier shows to be the manner of diffusion of heat waves into the interior of solid bodies.

It is very likely that it is in this conception of diffusion that the whole analogy lies. One cannot help recalling how the equations which Fourier has given for the transmission of heat along a wire are made to give the necessary formulæ for the transmission of signals along a submarine cable, and possibly also there may be some hint of the form of potential that the magnetic force in the interior of a core ought to be derived from, when one reflects that Lame has shown that while the equation $\nabla^2\sigma=O$ is satisfied by a potential

$$\int\int\int f\frac{\alpha, \beta, \gamma}{R}d\alpha,\, d\beta,\, d\gamma$$

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* See Oliver Heaviside Phil. Mag., July, 1886, and elsewhere.

which he calls one of the *first* kind, and which in stretched bars is known to be related to Young's Modulus,* the equation $\nabla^2\nabla^2\sigma = o$ is satisfied by one of the form

$$\int\int\int f(\alpha, \beta, \gamma,) R, d\alpha, d\beta, d\gamma$$

which he calls a potential of the *second* kind. This latter biquadratic differential equation is the subject of special mention by Emile Mathieu in his treatise on potentials.†

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* For example, if Young's Modulus is called $\frac{F}{C}$ then the above integral is denoted by F. C is related to the usual elastic coefficients λ and μ, as follows: For a cylinder with a force F per unit of area acting on its ends

$$C = F\frac{\mu+\lambda}{\mu(3\lambda+2\mu)};$$

therefore

$$\frac{F}{C} = \mu\frac{3\lambda+2\mu}{\lambda+\mu} = E$$

or Young's Modulus.

(See Rieman's Partial Differential Equations and elsewhere.)

† Emile Mathieu gives the equation $\nabla^4 u = o$ and shows that its solution is $u = \omega + \nu$ where

$$\omega = \int \rho r d\sigma$$

and

$$\nu = \int \frac{\rho'}{r} d\sigma.$$

("Theory of the potential," Vol. I., pp. 80–84.)

ρ and ρ' are functions of the co-ordinates of each point of a surface σ, and r is the distance of x, y, z, from $d\sigma$. ν and ω are first and second potentials of the two layers of matter which cover that surface. Reduced to the form

$$\frac{d^4u}{dx^4} + 2\frac{d^4u}{dx^2dy^2} + \frac{d^4u}{dy^4} = O$$

it has for solution the sum of two integrals

$$\int \left(r^2 \log\frac{1}{r} + \frac{r^2}{2}\right) \varphi ds + \int \log\frac{1}{r}\psi ds;$$

φ and ψ being two functions of a co-ordinate proper to determine a point of a contour S, and r the distance of the point x, y, from the element ds.

Every continuous function which in the interior of a curve S satisfies

$$\frac{d^4u}{dx^4} + 2\frac{d^4u}{dx^2dy^2} + \frac{d^4u}{dy^4} = O$$

is the sum of a first potential of a layer covering the curve S, and of the second potential of another layer on the same contour; likewise, also, the derivatives of this function of the first three orders.

We have another interesting analogy in the case of the equations of free vibrations of an elastic medium once subjected to applied forces, surface tractions, or both, and then left to its own forces of recovery. We shall find that the final equations are similar to those of the discharge of a condenser, especially if a dissipatory term be introduced into the equations of elasticity.

If u, v, and w, be displacements in an ordinary homogeneous elastic medium, at a point x, y, z, of the same, then

$$e=\frac{du}{dx} \qquad f=\frac{dv}{dy} \qquad g=\frac{dw}{dz}$$

will be the so-called elongations about the point x, y, z; being rates of variation of absolute displacements in proceeding along the coördinate axes.

a, b, c, are shears, if

$$a=\tfrac{1}{2}\frac{dw}{dy}+\frac{dv}{dz}; \qquad b=\tfrac{1}{2}\frac{dn}{dz}+\frac{dw}{dx}; \qquad c=\tfrac{1}{2}\frac{dv}{dx}+\frac{dn}{dy};$$

$$\Delta=\frac{du}{dx}+\frac{dv}{dy}+\frac{dw}{dz}=\text{the cubical dilatation;}$$

not necessarily uniform in all directions.

$$\theta_1=\tfrac{1}{2}\left(\frac{dw}{dy}-\frac{dv}{dz}\right); \qquad \theta_2=\tfrac{1}{2}\left(\frac{du}{dz}-\frac{dw}{dx}\right); \qquad \theta_3=\tfrac{1}{2}\left(\frac{dv}{dx}-\frac{du}{dy}\right)$$

are rotations.

$$P=(m+n)\,e+(m-n)(f+g)$$
$$Q=(m+n)\,f+(m-n)(g+e)$$
$$R=(m+n)\,g+(m-n)(e+f)$$

will be normal stresses across the three coördinate planes at the point $x\ y\ z$ and

$$S=na; \quad T=nb; \quad U=nc$$

are the tangential stresses, reckoned per unit area, at the same place.

The inversion of these formulæ will give

$$a=\frac{S}{n}; \qquad c=\frac{T}{n}; \qquad b=\frac{U}{n}$$

$$e=\frac{P}{q}-\sigma(Q+R)/q$$

$$f=\frac{Q}{q}-\sigma(R+P)/q$$

$$g=\frac{R}{q}-\sigma(P+Q)/q$$

Where q denotes Young's modulus; $n=$ what Sir W. Thomson calls distorsional rigidity; $\sigma=$ Poisson's ratio (which Poisson considered always to be $\frac{1}{4}$; Wertheim $\frac{1}{3}$, but which may apparently have any value from $\frac{1}{2}$ for incompressible bodies, to infinity as in the case of elastic gums. It is questionable, however, if the latter can properly be ranked as elastic solids.)*

In the general case of elastic distortion involving shear, dilatation, and variation of rotation we have either

$$m\frac{\delta\Delta}{\delta x}+n\Delta^2u+\rho(\ddot{u}-X)=O$$

$$m\frac{\delta\Delta}{\delta y}+n\nabla^2v+\rho(\ddot{v}-Y)=O$$

$$m\frac{\delta\Delta}{\delta z}+n\nabla^2w+\rho(\ddot{w}-Z)=O$$

wherein the rotations (or their variations) do not explicitly appear; or the following due to Lamé wherein they do appear, viz.:

$$(m+n)\frac{\delta\Delta}{dx}-2n\left(\frac{\delta\theta_3}{\delta y}-\frac{\delta\theta_2}{\delta z}\right)+\rho(\ddot{u}-X)=O$$

with a similar equation for y and z each.

If all applied forces and surface tractions are zero then these equations become those of an elastic system in motion under its own elastic recovery, or intermolecular forces, whatever these may be, and the most general motion possible consists of a series of superposed small harmonic vibrations of the points of the body about their positions of equilibrium, translations and rotations of the body as a whole being excluded. These vibrations may give rise to sounds and are ultimately dissipated as heat. The equations then simply lose the terms containing X, Y, Z, and their most general possible solution is of the form

$$\left.\begin{aligned}u&=u_1\tau_1+u_2\tau_2+u_3\tau_3+\ \ldots\ u_i\tau_i+\ \ldots\\ v&=v_1\tau_1'+v_2\tau_2'+v_3\tau_3'\ \ldots\ v_i\tau_i'+\ \ldots\\ w&=w_1\tau_1''+w_2\tau_2''+w_3\tau_3''\ \ldots\ w_i\tau_i''+\ \ldots\end{aligned}\right\}$$

The $u_i\ v_i\ w_i$ are functions of position ($x\ y\ z$) only, and the τ_i are functions of the time only. Any set, such as $u=u_i\tau_i\ v=v_i\tau_i'\ w=w_i\tau_i''$

*As before stated, the relations between these constants are

$$\frac{3kn}{q}=m=k+\tfrac{1}{3}n.\quad \sigma=\frac{3k-2n}{2(3k+n)}$$

generally. This makes $\sigma=\frac{1}{4}$ (Poisson) if $n=\frac{3}{5}k$; k is the pressural rigidity or the bulk modulus of Sir W. Thomson's writings; n is his rigidity; q is Young's modulus.

will constitute a simple simultaneous solution of the equations. On substitution of such a set of values the equations take the form

$$m\left\{\tau_i\frac{\delta^2 u_i}{\delta x^2}+\tau_i'\frac{\delta^2 v_i}{\delta x\delta y}+\tau_i''\frac{\delta^2 w_i}{\delta x\delta z}\right\}+n\tau_i\nabla^2 u_i=\rho u_i\frac{d^2\tau_i}{dt^2}$$

with similar equations for v and w each.

The necessary and sufficient conditions for a solution are that $\tau_i=\tau_i'=\tau_i''$ for all values of i. Because on this supposition left hand members can be freed from time functions and the right hand members from position functions; in other words, we have a separation of the variables, and the equations may be written

$$\frac{m}{u_i}\cdot\frac{\delta}{\delta x}\left\{\frac{\delta u_i}{\delta x}+\frac{\delta v_i}{\delta y}+\frac{\delta w_i}{\delta z}\right\}+\frac{n}{u_i}\nabla^2 u_i=\frac{\rho}{\tau_i}\cdot\frac{d^2\tau_i}{dt^2}$$

$$\frac{m}{v_i}\cdot\frac{\delta}{\delta y}\left\{\frac{\delta u_i}{\delta x}+\frac{\delta v_i}{\delta y}+\frac{\delta w_i}{\delta z}\right\}+\frac{n}{v_i}\nabla^2 v_i=\frac{\rho}{\tau_i}\cdot\frac{d^2\tau_i}{dt^2}$$

$$\frac{m}{w_i}\cdot\frac{\delta}{\delta z}\left\{\frac{\delta u_i}{\delta x}+\frac{\delta v_i}{\delta y}+\frac{\delta w_i}{\delta z}\right\}+\frac{n}{w_i}\nabla^2 w_i=\frac{\rho}{\tau_i}\cdot\frac{d^2\tau_i}{dt^2}$$

In these equations three functions independent of time are equated to the same function of time and not position. They must therefore all be constants. Let that constant be denoted by $i\rho$ (negative) so that

$$\frac{\rho}{\tau_i}\cdot\frac{d^2\tau i}{dt^2}=-i\rho$$

also

$$m\frac{\delta}{\delta x}\left\{\frac{\delta u_i}{\delta x}+\frac{\delta v_i}{\delta y}+\frac{\delta w_i}{\delta z}\right\}+n\nabla^2 u_i+\rho i u_i=O$$

$$m\frac{\delta}{\delta y}\left\{\frac{\delta u_i}{\delta x}+\frac{\delta v_i}{\delta y}+\frac{\delta w_i}{\delta z}\right\}+n\nabla^2 v_i+\rho i v_i=O$$

$$m\frac{\delta}{\delta z}\left\{\frac{\delta u_i}{\delta x}+\frac{\delta v_i}{\delta y}+\frac{\delta w_i}{\delta z}\right\}+n\nabla^2 w_i+\rho i w_i=O$$

with solutions $u=\Sigma(u_i\tau_i)$; $v=\Sigma(v_i\tau_i)$; $w=\Sigma(w_i\tau_i)$;

then

$$\frac{d^2\tau_i}{dt^2}+i\tau_i=O$$

This equation has in it no term involving loss of energy by friction or a similar cause.

The solution of

$$\frac{d^2\tau_i}{dt^2}+i\tau_i=O$$

depends on the form of i. If i be real and positive

$$\tau_i=A\sin\sqrt{i}.t+B\cos\sqrt{i}.t$$

if real and negative

$$\tau_i=Ae^{\sqrt{-i}.t}+Be^{-\sqrt{-i}.t}$$

These solutions indicate oscillatory motion of the elastic medium, or gradual subsidence to rest, according to the value of i.

Now as far back as 1842 Prof. Joseph Henry recognized that the discharge of a condenser might be oscillatory. Helmholtz seems to have so considered it in 1847 in his famous essay on the conservation of energy. In the Phil. Mag. for June, 1847, Sir William Thomson showed that when a condenser is discharged through a resistance having self induction L (or electro-dynamic capacity, as he termed it) and electro static capacity C of the condenser; being loaded originally with the charge q where $q=CV$ and $\frac{dq}{dt}=i=$ current at any instant, $=\frac{V}{R}$ by Ohm's law in the case of steady currents, then

$$\frac{d^2q}{dt^2}+\frac{R}{L}\frac{dq}{dt}+\frac{1}{LC}q=O$$

The general solution of such an equation is of the form

$$q=Ae^{(\alpha+\beta\sqrt{-1})}+Be^{(\alpha-\beta\sqrt{-1})}$$

$$\text{where } \alpha=-\frac{R}{2L} \text{ and } \beta=\sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}.$$

This equation reduces to one of the the form $\frac{d^2q}{dt^2}+\frac{q}{LC}=O$ when the resistance of the discharging circuit can be neglected in comparison with the self induction coefficient of the same. The discharges are then strictly oscillatory, the time of a complete oscillation, being $2\pi\sqrt{LC}$. When $R=\sqrt{\frac{4L}{C}}$ the motion has just ceased to be oscillatory or is *dead beat.* For sufficiently large values of R in comparison with L the value of β becomes imaginary, and there is no proper oscillation.

The fact of electrical oscillations in such cases has been sufficiently well established experimently by Feddersen, Rood, Lodge, Trowbridge and many others. Hertz and Lodge have traced out in great detail the dissipation of the energy of these vibrations, both in electro-magnetic waves and heating of the dielectric. The whole electro-magnetic theory of light assumes that when these oscillations are sufficiently rapid and the wave lengths correspondingly short, they are capable of affecting the retina and of producing chemical change. As we see from the expression above given for the time of an oscillation, such rapid vibrations and short wave lengths imply very small electro-static capacity and self inductance, such only as we could look for among molecular or atomic structures.

The next analogy has reference to the self induction of rods, and the magnetic forces within them when they are of other forms than circular.

It is well known that Coulomb made great use of the torsion balance in his establishment of the law of the inverse square of the distance as the fundamental law of force between electrical charges mutually acting on each other, and also between magnet poles. He appears to have considered in connection with this work the theory of the torsion of elastic threads, of hair, silk, and metals. He likewise appears to have been the first who established with reference to them, the simple differential equation

$$Mk^2\frac{d^2\theta}{dt^2}=-\mu\theta$$

where Mk^2 is the moment of inertia of the cylindrical thread round its axis, and μ the torsional rigidity. The solution of this equation gives the time of an oscillation. This time can also be observed. Thus the assumption that the force of torsion is proportional to θ can be tested experimentally. This is found to be the case for small arcs, and we have here the fundamental equation so much used in all magnetic and electric as well as general physical work.

For circular cylinders (solid or hollow) every straight line "is turned round the axis through such an angle as to give a uniform rate of twist (τ) equal to the applied couple divided by the product of the moment of inertia of the circular area into the rigidity (n) of the substance," i. e., the moment of the twisting couple,

$$M=n\tau\int\int d\sigma r^2$$

(where $d\sigma$ is an element of area), and τ is rate of twist.

Now Saint Venant has shown that in all but strictly *circular* cylinders (solid or hollow) there is a warping of each cross section in the vertical direction whose amount depends upon the position of the point relatively to the axis and the amount of total twist given to the prism.

Thus, if α and β be the y and x components of the strain, then according to Saint Venant

$$\beta = -\tau y + \frac{d\gamma}{dx}, \qquad \alpha = \tau x + \frac{d\gamma}{dy}.$$

If n is rigidity, the forces are n times these; hence $\frac{1}{2}n\Sigma(\alpha^2+\beta^2)$ taken over a section of the prism represents the energy of the strain (*potential*) per unit of length of the prism. γ, which denotes the warping, fulfils Laplace's equation, viz.:

$$\nabla^2\gamma = O, \quad \text{and also } \frac{d\gamma}{dp} = \tfrac{1}{2}\tau\frac{dr^2}{ds}$$

Here p denotes a perpendicular drawn from the center of the prism (or origin of coördinates) to a tangent to the surface of the same. [For current along a cylinder where the current density is $\Gamma_\circ$ and where Ω denotes (polar) magnetic potential we have an analogous expression

$$-\frac{d\Omega}{dp} = \pi\Gamma_\circ\frac{d(r^2)}{ds}\Big]$$

It is needless to point out that negative Ω represents γ, and $\pi\Gamma_\circ$ represents $\frac{1}{2}\tau$ in the elastic analogy.

In the ordinary notation of strains we have in such prisms under torsion $P=O$, $Q=O$, $R=O$, $U=O$, while

$$S = n\left(\tau x + \frac{d\gamma}{dy}\right) \qquad T = n\left(-\tau y + \frac{d\gamma}{dx}\right)$$

These cover the tractions and shears in the interior, or the body forces; while $F=O$, $G=O$, $H=T\sin\varphi+S\cos\varphi$, reach the surface tractions. Consequently

$$H = n\left(\frac{d\gamma}{dp} - \tau q\right)$$

or

$$H = n\left\{\left(\frac{d\gamma}{dy}\cos\varphi + \frac{d\gamma}{dx}\sin\varphi\right) - \tau(y\sin\varphi - x\cos\varphi)\right\}$$

if p be the above perpendicular and $q=$ distance from point of surface for which H is taken along the tangent to the foot of this perpendicular p.

For the usual form of couple, according to Coulomb's law, we should have as above

$$N = n\tau\int\int(x^2+y^2)dxdy,$$

which would require a valne of H equal to that just given to prevent warping; while if H be zero and warping freely allowed, the real couple necessary to produce the rate of twist (τ) would be less than this, i. e.,

$$N = \int\int(Sx - Ty)dxdy = n\tau\int\int(x^2+y^2)dxdy - n\int\int\left(y\frac{d\gamma}{dx} - x\frac{d\gamma}{dy}\right)dxdy$$

The last term is the time integral of the continuous couple by which an angular velocity τ would be communicated to the liquid in a closed infinitely light box of the same internal shape as the given prism to which torsion is imparted, and of length unity, liquid density n, as was shown by Stokes in 1843. (Math. and Phys. Papers, vol. I., p. 17.) The effective moment of inertia* of the liquid equals the correction to the torsional elasticity of the prism calculated by Coulomb's law as if the cross section were circular. α and β would in this case represent the components parallel to x and y of the velocities of the liquid relatively to the box. If in any case this couple be divided by τ we have the so-called *torsional rigidity* of the prism. For a prism of eliptical section

$$N = n\tau(J+L)\left\{1 - \left\{\frac{(a^2-b^2)}{(a^2+b^2)}\right\}^2\right\} = n\tau\frac{\pi a^3 b^3}{a^2+b^2}$$

where J and L are moments of inertia around x and y respectively.

For a triangular prism (equilateral)

$$N = \tau\frac{na^4}{15\sqrt{3}}$$

and so on.

Now Oliver Heaviside has shown that, calling H_1 and H_2, the two components of the magnetic force in a cylinder in which an electric current is flowing, and which is surrounded by a return conductor in the form of a closely fitting sheath (like the Deptford mains, for example), then

$$H_1 = -2\pi y \Gamma_\circ - \frac{d\Omega}{dx}; \qquad H_2 = 2\pi x \Gamma_\circ - \frac{d\Omega}{dy}$$

Likewise also, in analogy with the expression above given for the energy of a twisted prism, viz.:

$$\tfrac{1}{2}n(\alpha^2+\beta^2)$$

where α and β denote the x and y components of the twisting strain, we have, calling T the magnetic energy per unit of length of a rod carrying a current of density $\Gamma_\circ$ and which is enclosed by a return conducting sheath,

$$T = \frac{\mu}{8\pi}\Sigma(H_1{}^2+H_2{}^2) = \frac{\mu\pi}{2}\Gamma_\circ{}^2\Sigma(x^2+y^2) - \frac{\mu\Gamma_\circ}{4}\Sigma\left(x\frac{d\Omega}{dy} - y\frac{d\Omega}{dx}\right)$$

= Energy of magnetic field per unit length of rod carrying current.

"The lines of tangential stress in the torsion problem and the lines of magnetic force in the electrical problem are identical, and the energy is

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*By the *effective moment of inertia* is meant "the moment of inertia of a rigid solid which may be fixed within the box, if the liquid be removed, to make its motions the same as they are with the liquid in it."—Thompson & Tait, Nat. Phil., part II, p. 242.

similarly reckoned." Moreover, it appears that the ratios of the inductances of wires of different sections (taking the circular wire as a standard), are as the ratios of the torsional rigidities of rods of various cross sections in the torsion problems as worked out by Saint Venant For example, the torsional rigidity of a circular cylinder being

$$\frac{M}{\tau}=n\int\int d\sigma r^2=n\pi r^4,$$

and that of an elliptical cylinder being as above,

$$n\frac{\pi a^3b^3}{a^2+b^2}$$

the latter is essentially

$$=\frac{ab}{a^2+b^2}$$

times that of the circular cylinder. So if $L=\frac{1}{2}\mu$ (μ being permeability) be the coefficient of self induction per unit of length of a round wire, then

$$\tfrac{1}{2}\mu\frac{ab}{a^2+b^2}$$

is that of unit length of an elliptical one. So also $.4417\mu$ is that of a square one; $.3627\mu$, that of one of triangular cross section (equilateral); $\frac{1}{3}\pi\mu a/b$ that for a flat strip or sheet whose thickness is a and breadth b, and so on.

It will be noticed that these coefficients are the halves of those given by Saint Venant for the amounts by which the torsional rigidities of circular prisms of equal area are to be diminished when the cross sections are as given above, and warping of the cross sections is a part of the strain.

Now, as stated at the beginning of this paper, whatever may be the exact nature of electricity or magnetism, Clerk Maxwell has shown that the phenomena of both lead to the idea that electro-static lines of force and magnetic lines of force cause a stress in the medium they exist in, which is measured by

$$\frac{1}{8\pi}\,\mu\,F\,B$$

along the lines; being of the nature of the tensile stresses transmitted along tie lines in elasticity, and are accompanied by corresponding pressures at right angles to them. The phenomena are essentially of the nature of elasticity and point to a medium capable of sustaining stresses. The exact mechanism by which these stresses are produced is another question. It may be that mere attraction resisting displacement (as is sometimes assumed in theories of elasticity) is at the bottom of electrostatic strains, but it seems pretty certain that ether rotations are at the bottom of magnetic strains, and Sir William Thomson has shown that a medium can be conceived to which minute rotations give a *quasi* elasticity, such that the magnetic rotation of the plane of polarization of light can be explained thereby. On this view the quantity denoting permeability in the magnetic problem, and which seems to be the analogue of that which denotes rigidity in the elastic problem, would have very different values within and without an iron core. Within it would be smaller than without, so that the resistance to rotation would be less in soft iron than in copper or air. "In the place of the soft iron we must suppose ether of vastly less rigidity than that of the ether through the rest of space, whether copper or air. * * * To represent the case of a soft iron core of permeability 300, suppose the value of n [the rigidity] for the ether in the space corresponding to the soft iron core to be $\frac{1}{300}$ of its value elsewhere, and let the circuital forcive* be the same as that in the former case." * * * 'In this case the rotation, and therefore the energy of the ether within the core is 300 times what it is in the same region without the core, except near the ends.'†

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*By "forcive" Sir William Thomson seems here to mean the system of reactions aroused by absolute rotations in the ether just as elastic reactions are aroused by displacements in an elastic solid. Electricity in motion he seems to regard as a go-between for ordinary matter and ether. The latter is supposed to have no rigidity to ordinary slides — at least such as are involved in the ordinary movements of the ether; i. e., those movements that are caused by the passage of bodies through it at ordinary velocities.

†Thomson's Reprint of Mathematical and Physical Papers, Vol. III.

NOTE.—The whole subject of the properties and modes of motion of various *ethers* has recently been very clearly and powerfully treated by vector methods by Oliver Heaviside, in a series of articles in the London "Electrician." The old elastic solid theory of the luminiferous ether is shown to be quite inadequate to explain electro-magnetic relations.

NOTES ON A TRIP TO THE LIPARI ISLANDS IN 1889.

(WITH PLATE I.)

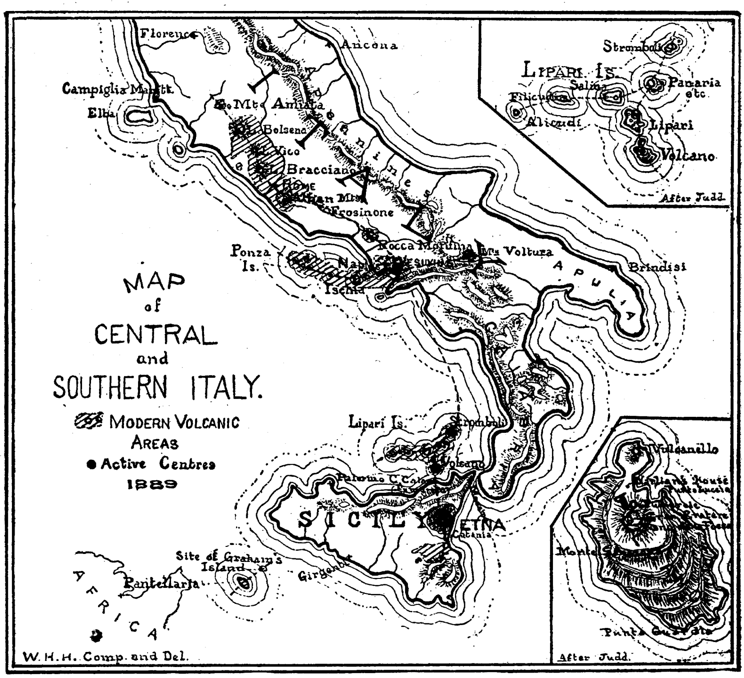
BY WM. H. HOBBS.

The Lipari or Æolian group of islands are all of volcanic origin and lie in the Mediterranean Sea between thirty and forty miles northwest of the Straits of Messina. There are seven large islands and ten islets, all of which received various names by the ancients. The Greeks made them the abode of Æolus, the god of the winds, and Volcano or Vulcano, one of the two active volcanic vents, was supposed to be the forge of Vulcan.

Lipari, near the center of the group, has figured prominently in history. Plundered by the Athenians and later by the Carthaginians, it was the scene in B. C. 260 of the capture of the Roman general, Cnæus Cornelius Scipio, by the Carthaginians. Eruptions of Volcano must have taken place in B. C. 204 and 126. In the middle ages and later the government changed hands frequently.

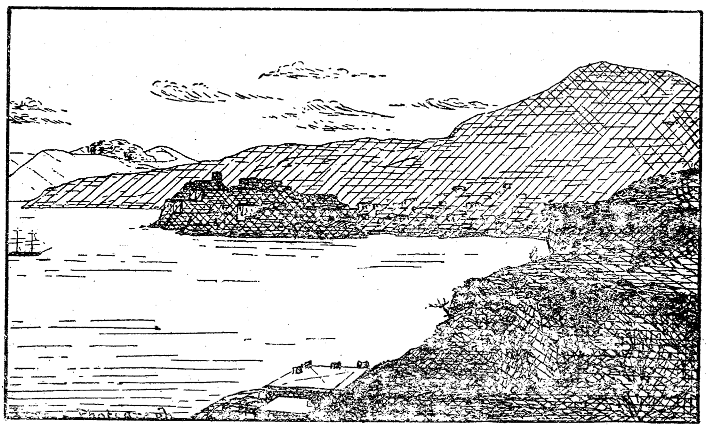
With the exception of Lipari and Salina near the center of the group, the islands are at present but little inhabited. Volcano, the southernmost, which till recently contained vineyards and important chemical industries depending on the emanations of the torpid volcano, has been entirely deserted since the outbreak of 1888 and 1889. Yet amid all this desolation is to be found some of the most romantic scenery in Italy. Lipari, the largest and most productive of the islands, has an area of ten to eleven square miles. On the east side of the island in a natural amphitheatre is the town of the same name, the walls of the amphitheatre being formed by the now extinct volcanoes; Monte Rosa, Monte Sant' Angelo and Monte della Guardia. Monte Sant' Angelo, the highest point (1952 feet), rises in the center of the island on the west of the town. Monte Rosa extends into the sea as a rocky promontory inclosing the harbor of Lipari on the north, while Monte Guardia serves a similar purpose on the south. In the middle of the crescent-shaped amphitheatre is an isolated rock projecting above the waters of the bay and joined to the mainland by a narrow neck. This rock is crowned by the sombre walls and towers of the Fort or "Castello," and is the site of the ancient town.

The modern town is erected around the fort and contains warehouses, where are stored for shipment the products of the island—the finest pumice stone, sulphur, currants, figs, Malmsey wine, etc. The vegetation is semi-tropical. Outside of the town the *opuntia* or prickly pear is abundant. Figs, agaves and grapes thrive. The great difficulty the inhabitants have to meet is the scarcity of water, which they collect for domestic purposes on their peculiar flat-roofed houses. For this reason oranges and lemons, so abundant in neighboring Sicily, are not cultivated here. The population was formerly much larger than at present, many of the natives having emigrated to America. As a consequence the price of a day's labor, which I was informed was a few years since about a lire (20 cents), has risen to about twice that sum. The Lipari islands lie somewhat off the line of tourist travel. Except by naturalists who are interested in their volcanic features, the islands are rarely visited, both because of the difficulty in reaching them and because of the primitive character of the accommodations.



The chief interest then of the traveler in these Islands lies in the volcanoes, and particularly the active vents, Stromboli and Volcano. The map has been prepared to show the relation of these vents to one another and to the other volcanoes of Italy. First of all it will be seen from the map how the vents are arranged linearly. It will next be noticed that the main fissure there indicated runs parallel to the backbone of the Italian Peninsula, which finds its extension in the mountain range skirting the north coast of Sicily. This principal line of vents begins with the extinct Mte. Amiata on the north, is extended in the crater lakes of the Roman Campagna — Lago di Bolsena, Lago di Vico, and Lago di Bracciano — in the Alban Hills to the south of Rome, Frosinone, the Rocca Monfina, and Vesuvius. Here the fissure line to continue its course parallel to the peninsular backbone would enter the sea. Following its approximate course we see that the Lipari islands form a continuation of it. The enlarged view giving the arrangement of individual vents on the islands indicates that this fissure forks in the island of Panaria, one branch passing westward through the extinct craters of Salina, Filicudi and Alicudi and probably continued in the shoal of Graham's Island and in Pantellaria. The other branch passes southward through Mti. Campo Bianco, Sant' Angelo and Guardia in Lipari, the vents of Vulcanello and Vulcano, and a submarine fumarole off Cape Calava on the north shore of Sicily, to Etna. Crossing the main fissure near Naples is a shorter one passing roughly east and west through the Ponza Islands, Ischia, Procida, the *Campi Phlegraeii* or Burning Fields near Naples, Vesuvius and Mte. Vultura on the eastern slope of the Apennines. This secondary fissure runs parallel to an outlying arm of the Apennines indicated in the Sorrento Peninsula and Capri. Vesuvius, the present focus of volcanic activity on the Italian Peninsula, is situated at the intersection of these two fissure-lines. Observations in other regions have shown that the largest cones have generally been built up where the fissure is widened from this or some other cause. In the Lipari islands, strangely enough it would seem, the active foci are not on Panaria where the fissure forks but on Stromboli and Volcano some distances to the northward and southward. It has been argued that Panaria was once the seat of an outburst so violent as to destroy itself, the remnants of a great crater being made out in the islets of the vicinity. To recapitulate, the positions of the Italian volcanoes illustrate well two almost universal features of volcanic regions; first, a linear arrangement of the vents, indicating that they are formed on fissures in the crust of the earth, and second a substantial agreement between the direction of this fissure and the trend of important folds in the strata (as shown in the prominent mountain ranges) which are structurally directions of weakness.

In the spring of 1889 I visited Italy in company with an English friend, Mr. Bernard Hobson, now lecturer in geology in the Victoria University, Manchester. It was our intention to observe as much as possible of the volcanic areas, especially Vesuvius and Vulcano, both of which were then active. In Naples we were privileged to meet Dr. H. J. Johnston-Lavis, the energetic and careful student of volcanic phenomena, the authority on Vesuvius as well as the best authority on the Italian volcanoes in general. Dr. Johnston-Lavis kindly furnished us with a letter of introduction to Mr. A. E. Narlian of Lipari, and supplied us with much valuable information concerning the islands. We had in our outfit a small camera belonging to my friend, to whom I am indebted for the photographs from which the figures in this paper were prepared. We were also fortunate to fall in at Naples with Dr. Brauns of Marburg, with whom I had made geological tramps in Saxony. He was accompanied by his brother and bound for the Lipari islands, so that we joined our forces, making a party of four. I have thought that it might be well to put on record some of our observations and at the same time collect the main facts in the history of Volcano.



The town of Lipari, as seen from Mte Rosa. Mte Guardia on the right. On the left, in the distance, is Volcano, with eruption beginning.

The trip to Messina was made without notable incident, unless it be the difficulty we had in getting aboard our vessel on the evening of our departure from Naples. The vessel does not come to the wharf, but is moored out some distance in the bay so that passengers must secure boatmen with yawls to go aboard. We selected what were apparently the least villainous of the Neapolitan boatmen lounging about the landing and bargained with them to take us aboard our vessel. Just as the landing stairs of the vessel were reached a demand was made for double the tariff. I being nearest the landing stairs jumped out, throwing the boatmen the rate agreed upon. Before the others could do so the boat was pushed away from the vessel. Mounted to the deck, I saw and heard a lively discussion between my friends and the boatmen, carried on in bad Italian with occasional German and English interjections on the one hand and very voluble Italian on the other. The boat drifted farther away, and in the dusk I could make out that the matter was apparently settled by the Italians sturdily rowing the boat toward the shore. Before they had reached it a warning whistle sounded from the vessel; again commotion in the boat and soon a change in its direction. This time my friends reached the vessel, but only by submitting to the extortion. We must have passed near Stromboli in the night, but we were too tired from our tramps around Vesuvius to watch for the "Lighthouse of the Mediterranean." After various contacts — more or less agreeable — with the Sicilians, and after watching them prepare macaroni or load oranges on British vessels bound for America, we embarked on the little steamer which leaves Messina semi-weekly for Lipari, and at midnight passed between Scylla and Charybdis.

At six o'clock the next morning, the 7th of April, we cast anchor in the harbor of Lipari. Hurrying to the deck, I saw a picture I shall long remember. Before me were the quaint town, the fertile slopes about it and the sombre but picturesque *Castello*, the whole hemmed in by frowning crater walls. A few miles south rose the wide-mouthed cinder-cone of Volcano, the most beautiful and symmetrical of all cinder-cones. Around our small steamer were numerous yawls manned by natives, who were quarreling for position at the landing stairs and vociferating in a manner only possible to Italians. We submitted to be taken ashore by them, and found them far less disagreeable than we were led to expect from acquaintance with their Neapolitan brothers. An experience of two months in Italy, spent as much in the country off the lines of tourist travel as in the cities, taught us that the most troublesome Italians are in the cities, but especially in Naples. One needs to stop in Naples to understand how Mark Twain could spend two weeks "studying human villainy." Before I had reached the shore I had seen three grand explosions of Volcano accompanied by a loud rumbling and the sending up of a great cloud of dust and ash, and followed by the rattling of the projectiles as they fell back in the crater or rolled down the outer slope into the sea. After a moment the outburst would be over, and the only visible remnant would be a dense black cloud floating away under the light breeze to the eastward. At greater distances in the same direction could be seen similar clouds due to earlier explosions. Between explosions a large fumarole sent out a volume of white vapour resembling the '*scape* of a locomotive. We were soon housed at the one rather primitive *Locanda* or hotel that the town supported, and hastened to make the acquaintance of our guide, Bartolomeo Nicotera, who was to serve us in our trip to Volcano. That day and the one following were spent on Lipari in examination of the old craters and acid lava streams, and collecting from the obsidian, pumice and liparite so abundant in the vicinity. But Volcano was an attraction that outweighed others in our minds, and to it I shall direct attention. I shall therefore interrupt my narrative to give something of its history.

The island on which the volcano is located, which bears the same name — Volcano or Vulcano, has an area of about eight and one-half square miles. The crater, the "*Gran Cratere*" of the natives, is situated a little to the northward of the center of the island. On a peninsula at the north end of the island is Vulcanello, a small triple-cratered hill joined to the mass of the island by a low and narrow neck of land. This forms two bays, of which the one on the east side is called the *Porto di Levante*, and is the landing place for boats. The present mountain is a cinder-cone *par excellence*, and rises a few hundred yards south of the landing. The crater had a diameter according to Johnston-Lavis (in September, 1889) of about 250 metres and a depth of 30–40 meters below the lowest lip. (Scottish Geographical Magazine, VI., p. 147.) These values are much lower than those of Baltzer taken in 1873, who gives the diameter of the crater as 900 metres. The depth of the crater he measured and found to be 86 metres (Zeitsch. d. d. geol. Gesellschaft, 1875, p. 9). The height of the lip of the crater (the *Piano della Fossa*) is about 700 feet above the sea. With the exception of a moderate-sized obsidian stream on the northwest flank, the material of the cone seems to be entirely fragmentary. Baltzer, in 1873, sketched beds showing the dip of the material within the lip of the crater to be toward the center. Near the obsidian stream, just outside the crater rim on the north side, is a secondary crater about 200 feet in diameter which has long been an active fumarole. Encircling the present crater at a distance of one-half to three-quarters of a mile is an older explosive crater, the highest point of which is Mte. Saraceno to the south. To the south of this Judd has described three still older craters, the centers of which lie in the medial line of the island. All these older craters including that of Monte Saraceno, unlike the present active one, are essentially composite in character being made up of lavas with ash, lapilli, etc. The lavas near the south of the island are doleritic in character, rich in olivine, while to the north they are composed of trachytic rock. The beds are traversed by radial dikes showing the former existence of parasitic cones. Some of these dikes belong to the curiously hollow type recently described by Johnston-Lavis from Vesuvius, Stromboli and this locality. ("L'Eruzione del Vesuvio nel 2 Maggio, 1885," Ann. d. Accad. O. Costa d'Asp. Naturalisti, Era 3, Vol. 1. Nature xxxviii, 13.) These are due to the draining out of the lava below after it has been injected into the fissure and a portion has consolidated on the walls.

The structure of the island shows clearly that the early eruptions which built it up were largely of basic lava, that the active vent was migratory northward along the medial line of the present island, each successive eruption blowing out the north wall of the crater formed by the preceding eruption and affording more and more acid material. According to Scrope the present form of the volcano is largely due to the eruption of 1786. After this eruption the mountain passed into the solfatara condition, or condition of moderate fumarole activity. The gases — boric acid, sulphur, sal ammoniac, etc.— were collected by the Italian firm of Nunziate and later by the English firm of Stevenson. The method of collecting was to pile cinder over the fumaroles so that the materials would sublime, then remove to the manufactories for further concentration. One of the manufactories was within the crater and the other on the shore of the *Porto di Levante.* The competition from Asia Minor and California resulted in the neglecting of the boric acid industry, but it was proposed to build large leaden chambers over the fumaroles for the better condensation of the sulphur gases, when the increasing activity of the fumaroles interrupted the work. The light eruption which began in August, 1873, and ended in December, 1874, has been described by Baltzer and presents many interesting features. Flames, once thought so common but now known to be extremely rare at volcanic eruptions, were observed in this instance. They showed a tinge of green, doubtless to be ascribed to boric acid. The most interesting feature, however, was the fall during the early stage of the eruption of a fine snow-white powder, which covered the island to a depth in some places of three to four centimetres. This was followed by a gray ash of the ordinary type, nothing more nor less than finely divided liparite lava. The snow-white ash, however, was 94 per cent. silica, and was shown to be tridymite by its low specific gravity, its solubility in alkalies and its optical behavior. Baltzer has offered the plausible explanation that this material is formed during the long period of quiescence, by the action of the acid gases of the fumaroles on the plug and walls of the chimney under the high pressure and temperature which must attain there. This explanation accounts for the absence of the snow-white ash from the later phases of the eruption. (See Baltzer, Zeitsch. d. d. geol. Gesellschaft, 1875, pp. 3–29.)

After this very light eruption, which was not violent enough to expel the workmen from the crater, the old conditions of fumarole activity were resumed. In 1886 there came a slight eruption which cleared out the bottom of the crater, since which time it has never entered into its former quiescent condition. Before 1888 the English firm owning the sulphur industry had set out large vineyards and fig orchards at the north end of the island. Mr. A. E. Narlian, who was in charge of these, had his villa a few hundred yards north of the cinder cone of Volcano. In August, 1888, occurred an outbreak which, though not to be ranked with eruptions of the first order of intensity, caused much damage. The main facts connected with this eruption were reported to us by Mr. Narlian at his home in Lipari. They were contained in a letter to Prof. Johnston-Lavis, and were published in the London *Times* and in the Report of the British Association for the Advancement of Science for 1888 (p. 664).

On the 3rd of August an outburst took place in the crater, of sufficient force to throw projectiles out to the sides, whence they rolled down the slope. This lasted ten to fifteen minutes and was repeated at intervals of twenty or thirty minutes. With the throwing out of the projectiles there would be a great rush of thick smoke (mainly steam and dust). Such eruptions had been observed several times before within the thirteen years Mr. Narlian had been on the island, and he was led to hope that these would end like former eruptions. Toward evening the leading fumarole (the secondary crater on the north lip of the main crater), which had given off offensive gases for some months, showed a clear, high flame tinged with green or blue. Mr. Narlian was so alarmed that he did not undress for the night. Towards morning he fell asleep, but was soon awakened by a tremendous din caused by the fall of projectiles on the roof of his villa. Securing his children, he ran to the drawing room, but as the door was opened a red-hot mass of pumice, two feet in diameter fell through the roof, ceiling and floor, smashing and setting fire to everything. Turning back, they reached the verandah by another passage, when a second red-hot block, similar to the first, fell at their feet, was smashed to fragments and burned the feet and legs of the two boys. Mr. Narlian, helping his children as best he could, ran away from the thundering mountain toward Vulcanello. The men, in their despair had carried off the two available boats, leaving him without any means of escape. He was obliged to remain on Vulcanello, almost within reach of the falling blocks, until taken off about noon by boats from Lipari.

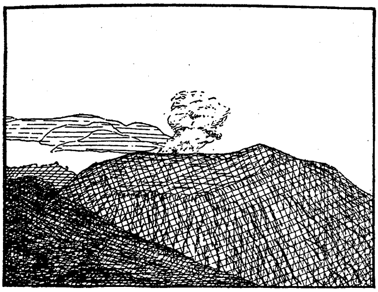
The violence of the eruption diminished somewhat in intensity, but to the end of the month the noise continued to be heard in Lipari (at a distance of six miles) as a prolonged thunder. Almost the same condition of affairs continued through the year, the quantity of projectiles diminishing somewhat and being replaced by fine ash, which mounted as a black cloud to a height of three miles or more before floating off.

When I visited the volcano on April 9th of the year following, this was the condition of affairs, with the intensity of the outbursts somewhat further diminished. We engaged four swarthy boatmen and their boat for the entire day for twelve lires ($2.40). These men, who rowed standing, were dressed in bright colored shirts and trousers rolled nearly to their hips. Their sandals they carried in their pockets while in the boat. Enormous brass rings were stuck in their ears. We carried provisions and wine, as nothing to eat or drink could be obtained on the island. The morning was clear but the sea was quite choppy. I had never seen water of such a beautiful tint. The oars as they dipped in the water showed a beautiful turquois blue. We landed at the *Porto di Levante*, the boatmen carrying us through the surf on their shoulders. We visited Vulcanello and photographed the explosions from that point. One of these photographs has been engraved, and shows the great dust-cloud ascending and curiously branching as it attains a height above the crater about equal to the height of the mountain. (See Plate I., Fig. 1.) The interval between eruptions varied from three to four minutes to a half hour.

From Vulcanello we visited Mr. Narlian's ruined villa (about three-fourths mile from the crater), which presented a most desolate appearance with its smashed and charred roof and walls half buried in ashes, lapilli and bombs. The vine and fig plantation was almost completely buried in cinder and entirely ruined, occasioning a loss of about £40,000 sterling. The entire plain (Atrio) between the mountain and the encircling ring of Monte Saraceno and Monte Luccia, is covered with lapilli to a depth of several feet, and this is strewn with projectiles (the so-called "bombs") of all sizes from such as are smaller than one's fist to those several feet or even yards in diameter. The larger ones have dug themselves great pits in the loose lapilli so that they are nearly or quite buried, the lapilli being thrown out to a considerable distance. Whenever the mass was more than a foot in diameter it was sure to be cracked or broken from the force of its fall, being composed of a coarse acid pumice. Their porous character explains how they could attain to such extraordinary dimensions. We saw numerous specimens that had clearly been over four feet in diameter and at distances of one-half to three-quarters of a mile or more from the crater. Mr. Narlian mentioned one near the well of his house that he thinks was ten yards in diameter. This I did not see. A projectile at least three feet in diameter we found well up on the slope of Monte Saraceno in the encircling "Somma." The structure of these projectiles is very interesting. Their shape approaches roughly to an ellipsoid and generally one of rotation, though they are really polyhedral with peculiar warped plane surfaces. Pear-like shapes are not found and their presence would hardly be expected when the material is so porous. They have an outer glassy skin, about a half-inch thick, with fine scattered vesicles. This has a gray surface color like pumice, with cracks opened in and between the warped bounding surfaces. Dr. Johnston-Lavis has aptly termed this unique structure the "bread-crust structure," since it closely resembles both in appearance and in probable manner of formation, that of a baked bread crust, in which cracks have formed from the expansion of the gas in the dough after the surface has hardened. The larger cracks show upturned edges and reveal at the bottom of the crack a fine-grained spongy pumice. Everyone will recollect analogies to this in bread. The interior of the "bomb" is pumice with in general an increase in the size of the vesicles toward the center. (See Plate I, Figure 2.) These vesicles are usually elongated in the direction of the radi-vectori of the bomb. This is doubtless to be ascribed to the centrifugal force developed by the rotation of the mass in the air. The petrographical and chemical relations of these projectiles will be treated in another paper.

The explanation of Dr. Johnston-Lavis for the formation of the projectiles is so satisfactory that I quote from him:

Their structure is "due to the obsidian reaching that intermediate stage between a liquid and a solid or in other words a state of intense viscosity, like slightly warmed sealing wax or hardened Canada balsam, which break when exposed to strong and violent mechanical stress but bend under a slight and gradually applied one. The magma in the upper part of this volcanic chimney seems to be in this critical state, and, as the vapor collects and escapes from the more heated and fluid portion beneath the upper part, is broken in fragments and ejected, when it is relieved from the surrounding pressure and allowed to expand. The crust has cooled along the cracks before this, and continues to do so, as it is whirled through the air, and after its fall, whilst the interior expands at the same time, innumerable vesicles being formed from the water dissolved in the magma separating as steam. This expansion causes the cracking of the hardened crust and in some cases protrusion through the crust." (Proc. Geol. Assoc. London, XI, p. 390, August, 1890.)



View of Volcano from Mte Saraceno, showing the "Barrancos" and the beginning of an eruption. The island in the distance is Lipari.

We climbed Monte Saraceno and Mr. Hobson again photographed Volcano during the explosion. From this point the cone shows well the gullies (Barrancos) which in other regions figured so prominently in the "elevation crater theory." From this point we could see that the wind, which was fresh from the west, carried the projectiles of the eruptions to the east of the crater. Owing to this favorable circumstance we hoped to be able to safely ascend to the crater from the west side. Mr. Hobson and myself therefore attempted the ascent and had toiled half way to the summit through lapillo and ash lying at the angle of repose, when a severe squall that had been threatening for some time, broke upon us. The sea about the island was lashed into foam. The strong wind picked up the loose ash and lapilli and drove it against us with such force that we were compelled to cover our heads with our coats to protect our faces. We gave up the ascent to the crater and made the descent, which was as easy as the ascent was difficult. Reaching the *Porto di Levante* we sheltered ourselves as best we could from the wind and rain till toward evening, when the violence of the storm abated and we made our way to Lipari by dint of hard rowing in a heavy sea.

On the following day with our faces still toward Volcano we took our departure from Lipari on the little mail steamer from Messina, which had again cast anchor in the harbor. After the volcano had almost vanished from sight, we stretched ourselves on the deck under the bright sun. Rising some moments after I noticed that my clothes were being covered by the fine liparite ash of the mountain which was borne to us by the wind. Spreading a paper on the deck we were able to collect a considerable quantity of the material. Thus we bid our adieu to Volcano.

Some five months later a party from the Geologists' Association of London visited the island under the guidance of Dr. Johnston-Lavis. They succeeded in reaching the crater's edge. They saw the inner sloping walls of the crater to be made up of ash with scattered "bread-crust" bombs of all sizes. In the bottom were conical depressions which emitted no steam between eruptions. Explosions at intervals of five minutes to half an hour would raise the whole or part of the bottom in a vast cloud, such as we had observed, estimated to attain to a height of 8,000 feet. (Proc. Geologists' Association XI, p. 389.)

It is interesting in this connection to recount certain accidents which have happened to the telegraph cable between Lipari and Capo Melazzo in Sicily. This cable passes quite near Volcano. On the 21st and 22nd of November, 1888, a rupture occurred near Volcano and the cable was buried. Again on March 30th, 1889, a less serious break, and again on September 11, 1889, a more serious one occurred. These facts point to the formation of a submarine vent quite near Vulcano.

University of Wisconsin, June 2, 1892.

EXPLANATION OF PLATE I.

Figure 1.

View of Volcano looking south from Volcanello, engraved from a photograph by Bernard Hobson, B. Sc., taken April 9th, 1889. The dust cloud mounting from the crater, which in its initial stages showed but a single important lobe, has just sent off lateral lobes the distribution of which is very symmetrical to the central lobe. The active fumerole on the north lip of the crator (in shadow) gives a smaller volume of steam than in the interval between explosions.

Figure 2.

"Bread-crust" projectiles from the Atrio to the west of the Cinder-Cone of Volcano. At the left of the figure is a bomb about the size of a turkey's egg, which shows the polyhedal shape, the hard, smooth surface, and the peculiar cracking. On the right is a fragment from a bomb which was about the size of a man's head. The piece is three and one-half inches high. The upper is the original outer surface and shows a vesicular obsidian extending to a depth of about one-half an inch. The rest of the material is pumice, the vesicles of which are ellipsoidal with their longest axes roughly perpendicular to the original obsidian surface. The size of the vesicles increases toward the center of the bomb.

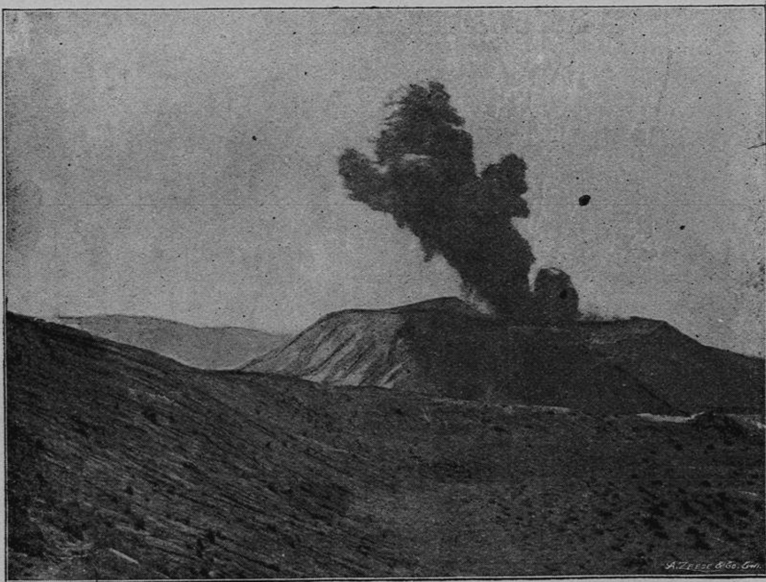


FIG. 1.

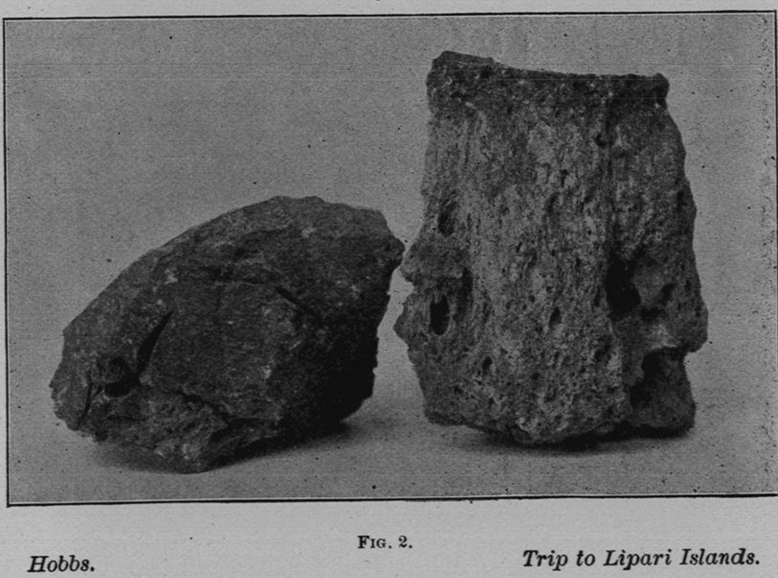


FIG. 2.

SOME SUGGESTIONS CONCERNING METHODS OF PSYCHOLOGICAL STUDY.

BY J. J. BLAISDELL, BELOIT, WIS.

I feel myself already rebuked in bringing before you the matter which I am about to read. Not indeed because it is, in my view, for substance without importance; but for the reason that in the way of its putting, it is crude and in a measure meager and inadequate. It will have this element of advantage, that it is beaten into deep personal convictions by not a few years of teaching the branch in question, and put to the test of its truthfulness by having contributed to helping a number of fair minds into an apparently well-grounded habit of good living. What proves to be well adjusted to normal living—the best test of the significance of theories—cannot be altogether spoiled by the manner or method of its presentation. What suggestions I have to make upon the methods of teaching Psychology I should like to bring before you in the way of several questions.

1. Should it not be more thoroughly insisted on that psychology is a science—a science of observation—an inductive science? A very common use of the word science makes it designate only a concept of the severa d partments of what may be loosely described as physical, natural, material processes. It often means any such concept as may be gathered up piecemeal of a conglomerate of unrelated facts in a given field, without insisting on the logical coordination of these facts, and their subordination to some generic principle. Even in many cases wherein the claim of psychology to a scientific dignity is allowed, it is done with a timidity which seems to arise from a suspicion that as a science it lacks the clearness, distinctness and adequacy, which constitute the perfection of scientific character. If indeed there be just question whether psychology is thus usurper of a place in the category of the sciences, it is fair certainly to give it thorough challenge. If, on the contrary, it presents a defined field of fact with its exact extension and intension, and is entirely capable of differentiating and relating its contents, it is time that scholarship should clear its habit from undue bias derived from study by the five senses and, with explicit commitment, admit it into the order of the sciences,—this one, without which, if its scientific character be made good, all others would wield a barren scep-

ter. The phrase, "science of psychology" should be pronounced in a major key. In a curriculum of studies the designation "science" should certainly as much include psychology as geology or chemistry. The word "scientist"—barring the infelicity of its mongrel etymology, which makes it a pain to use it,—should not denote one more than the other. There is no reason why science should mean science of matter more than science of mind. College boys and university men should not be allowed to grow up with the paralogism bred into them that science is even by one whit of eminence a conquest of five senses—sight, hearing, touch, taste and smell.

Equally questionable is it whether science should not register soundings upon its scientific chart in regard to the word "observation." One is tempted at times to wonder whether in the great eagerness after the discovery of new facts in the wide realm of the unknown, we have not not only fallen into mistaken views of the relation of the departments of science to each other, but failed to hold proper balance of appreciation as regards the very instruments of discovery themselves. If the five senses have, in whatever alliance, yielded up wonderful disclosures to the throbbing heart of the student, his wisdom lies in keeping due confidence in other means of approach to the arcana of things. We can often sail by looking at sun and stars or watching ocean currents; it is convenient to have in reserve the methods of dead reckoning. We must remember that science is the concept of the whole universe, that there is really only one science, and that there are paths up the inland heights of that awful realm which no vulture's eye hath seen. Is not consciousness, by which the phenomena of mind are cognized by mind, an implement of observation as trustworthy as the eye or the ear, or has it failed oftener the explorer who has used it? I am not now speaking of inferences, though one does not easily see why inferences from consciousness are more likely to be mistaken than inferences from the disclosures of the telescope or the spectroscope, for they both stand on the same level of safety. I only speak of the facts of mind which are the subject matter of psychology, and suggest that, disclosed as they are in consciousness, they are as much matters of observation as the things which are learned under the acid or the hammer. While, as is fully recognized, the physiological laboratory may be invoked as an ally to illustrate and perhaps supplement them, they are facts of observation in consciousness, and their distinctness and fullness of disclosure entitle psychology to be classed with as much firmness as an observational science like physiology or natural history. There is no apparent justice in arrogating to physiological psychology exclusively the designation empirical psychology, as has been strangely done by some of late. It seems much like the forwardness of unripe intelligence, the crudity of a late arrival in the realm of metropolitan science.

Nor have we less reason to put questions to a disposition to speak of psychology as if there were some uncertainty as to its being an inductive science. It would be salutary as a mental alterative if we would often really recur to Francis Bacon, a man as much abused by modern science as Aristotle was abused by him. It is hard to see why the facts of mental science, which lie within the horizon of consciousness as truly as those of the heavens lie within the range of the eye may not be induced into general concepts, and by still further induction constituted into a hierarchy of principles so as to make psychology an inductive science of observation. Certainly any possible science of physiological psychology is conditioned upon the authenticity of consciousness, for its "cortical irritations" are only disjecta membra, to whose disclosure consciousness holds the key of witness.

2. I would like to express a suspicion I have felt in regard to the prevailing conception of laboratory practice as applied to the study of psychology. What I have in mind does not primarily concern the laboratory practice which is made so much of in investigating psychical processes by the aid of physiological experiments. No objection can be made to such adjuvant processes for throwing light upon the occult phenomena of volition, thought and feeling. I can see no reason, however, why such laboratory practice should not in honesty be designated as physiological. Is it not physiological practice? No doubt much curious light has been thrown upon mental processes by such experiments, though perhaps their value has been relatively overestimated, particularly in the inferences they have been supposed to justify. At all events, of the two inferences, spiritism and materialism, the former is more likely to be the ultimate one than the latter.

What I have in mind is rather the unduly restricted conception of laboratory practice, which makes it inapplicable to the immediate investigation of mental phenomena by consciousness. What is a laboratory? Is it anything more than a place where the student proceeds to explore, by experimental methods of scrutiny adapted to the theorem in question, any conceived phenomena? And laboratory practice is such personal beleaguerment of the field of fact, is it not? Is there any reason why it should be prosecuted exclusively with the eye unarmed, or armed with the microscope and knife? The phrase, "laboratory practice," is freely used in respect to the corresponding method of studying history. It is not insisted on that history should be elaborated with the eye or the ear, or literature. And so, in psychology, for the eye and the hand consciousness may as well be substituted, and under the scrutinizing eye of introspection the procession of mental states may be made to pass and give account of itself. It may very likely be more difficult to differentiate and diagnose the elements of the theorem in mind than in matter, so that the student is more likely to need a mentor, and it is not probably as safe to leave the tyro to himself, because he is not so used to moving in realms of mental facts as in realms of sense. Accord ingly, Plato excluded from his esoteric classes men who had not studied the mathematics. He will very likely require for safe conclusion an older student at his side to hold the object of investigation in the focus of view, and help him spell out the unfamiliar objects in those invisible regions. So Plato needed Socrates—Plato, the teacher of the ages. It may be done in the class room, which you may call a laboratory; but it is a laboratory, where results are reached—under any good teacher—by laboring them out by the use of a cutting and coming again process as truly as corresponding things are laborated in chemistry or biology. In fact the ancient method of recitation by memory—and it had its excellencies, which in the new days will be altogether lost to very great damage—is everywhere modified, and there is no good teacher, nor was there ever a good teacher in any department of instruction, whose recitation room is not a laboratory. So Gorgias thought when he sat in the laboratory of the great typical teacher, Socrates. So Polus thought when he was dealt with by the great teacher as Marsyas was dealt with when he thought to excel Apollo in the use of the lyre.

Indeed, to say one of the many things which one would like to say in caution about this laboratory work, there is less likelihood at present of one danger from the use of laboratory methods in psychology than in the material sciences, from this very need of the presence of a teacher to superintend laboration. It is coming to be more than suspected by thoughtful observers that what may be said to amount to a fad of laboratory practice is, in the hands of a multitude of teachers, only the turning of the student into a laboratory supplied at a great cost with the requisite implements, to find out, by tardy and unmilitant processes, the less or more significant facts in a department of things, without seeing to it that in the student's mind these facts are properly coordinated and reduced to a whole of scientific structure and import. The truth is, that no body of facts in any science can properly be left, as found by the student of whatever perceptive sagacity, without being constructed into the wholeness of their scientific relation by a teacher's broader and maturer comprehension of them, and interpreted into the student's mind in all their mighty and living import out of the heated furnace of an endowed teacher's aroused heart. All good teaching is interpretative empowerment—whatever the thing taught, and not in the way of mere intellectual stimulation in order that they may study, as Prof. Moses Stuart used to say, "like a tiger," but in the way of making the perfect concept elaborated mighty to the volume and momentum of living. And any good teacher of psychology is all the better circumstanced, by his necessity of holding his mind close to the student's mind, for a laboratory practice which will minister to the highest ends of teaching and study. That teaching is everywhere the best—and none other is good—which makes thoroughly scientific concepts generative in the pupil's mind of most productive momentum in manhood and womanhood.

3. A third question I have to raise is in reference to the proper order of topics in the study of psychology. It has seemed to me very strange that the treatment of psychology should persist in handling the functions of mind in the order of intellect, sensibilities and will. It of course suggests itself as a reason of this order that by the intellect are furnished the facts by which the sensibilities are awakened, and that in these the will finds its immediate motive of purpose. This is no doubt plausible, and is very likely the traditional reason of the order. Some writers in psychology have been controlled by a rhetorical reason, and have constructed their work on the principle of the law of rhetorical cadence. The exaggerated relative importance attached to the intellectual function of mind has not only led to giving intellect first place in treatment, but even to making it the exclusive topic, allowing at least small and insignificant attention to the executive powers, perhaps putting them over for consideration into the department of ethical science. It can easily be explained that one who is handling psychology in the interests of illustrating the evolution theory and setting forth a genesis of mind in that interest, as Hoefding and many others, will adopt that method. But no such reason can be assigned in the case of many writers.

The preliminary question ought fairly to be discussed, which one of the two conceptions ought to rule in the teaching of science. Mr. Herbert Spencer would no doubt answer, that the various sciences ought to be taught entirely in the interests of the one comprehensive natural procedure of the universe. Psychology has its worth and its interest for us as a stage in that cosmic procedure, and the sole dominating principle of its teaching is loyalty to this method of procedure. There is but one science in this view, that of evolution.

Some others of us believe in the reality of final causes, and in a moral final cause, and that man's being is determined by reference to that moral final cause, so that he is not only a stage in the cosmic series but a responsible actor in view of the series. Indeed, it would seem that man is hardly a co-ordinate stage in the series, but that the series is so related to him that he is, so far as this world is concerned, its final cause. He seems to be protagonist in a system which constitutes his arena. We think him disengaged from the tyrannic current of natural processes, and that he has in himself, and not in nature, the law by which he is to be studied and estimated and held responsible. Indeed, if this is true of man, it is, in a related way, true of everything else. The question is, whether we are to hold everything as part of a stage of aimless nature, or as related to a final moral stage. I suspect that the real question which underlies our method of teaching at the present moment is squarely this, whether we are pupils of Herbert Spencer or of Socrates, or—to mention no other—of Jesus Christ. This, apparently, is the only issue which—whatever may have been the reason in the past, and with merely traditional teachers today—will control our practice as regards the order of our topics in teaching psychology. We may say with Hoefding, In the feeling of responsibility and in repentance is implied no more than that the individual recognizes that he has willed the action, and, by virtue of the better mind to which he has come, condemns himself for having done so. The idea that it would have been equally possible to have acted in the opposite way does not make itself manifest in all individuals, and, when manifested, must be explained partly as the confusion of a metaphysical notion with psychological experience, partly as an illusion which is very natural when the individual has his new conviction and, with a strong desire to have acted otherwise, is vividly conscious himself at the moment of action, without, however, being able to survey and realize all the inner and outer condition in actual operation at the time." Or with Ziehen, "The idea of a casual relation is an idea of similarity. The analysis gives no ground for the assertion of a specific faculty of will. It is different with the conception of moral responsibility. This conception is contradictory to the deductions of physiological psychology." On the contrary, with the letter of Hoefding's last word, spoken no doubt with another view: "However far it may be possible to explain man through the world, the world in its turn is always explained through man." According then as we explain mind as a procedure of persistent and transmitted "cortical irritations," or as a citizen of the spiritual commonwealth, we must determine where in his being to begin its study.

My question is only whether, if we are teaching mind not as a persisting procedure of "cortical irritations," but as a citizen of a spiritual kingdom ordered in good, we had better not begin with the will, which in this latter view is the man. In my own practice, if I may be allowed to speak of it, I have done this with comparatively most satisfactory results in ways of which I cannot now speak. It has seemed to me that the will should be emphasized in treatment as the prime and mainly constitutive function of personality, the form of the function being carefully studied, its relation to causation, its organic connection in the mental economy, and the conditions under which it is related to the system of which individual mind is itself only a co-operative member.

If this primary and leading consideration is given to the will, will not the intellect and sensibilities take the place in the study of psychology not merely secondary in the order of time, but secondary and ancillary in the order of function? Will being the main constituent of personality and life being progressive adjustment to environment, environment will relate itself to personality through avenues of intelligence. It becomes then the office of the cognitive powers to gather in, as data for voluntary procedure, the facts of the environing universe, furnishing them for memory to cherish, judgment to conceive and imagination to represent, constituting therein science, the handmaid of living. For the purposes of character, however, will, and will does not fulfil its citizenship save as it becomes character—is placed under discipline of alternatives, in adjustment to environment, only by means of the appeal of sensibilities; and consequently feeling, in its various forms, becomes a second subsidiary function in the mental life. This order in the treatment of mind—which, to do it justice, should be much more fully given in detail—has the justification that it deals with mind as we deal with every structure, whether vital or mechanical. Of course this is said only on the supposition that mind in itself has a final cause—that man as a free being is accountable under moral order. If we are intelligently considering, in order to understand, a locomotive engine, we go straight to the heart of this world's wonder in the force which moves the mighty pistonrod. From out that heart, we follow back to the steam and the fire which generates it, and the furnace and the boiler as needful conditions, and forward to the valves and the cylinder chamber, the levers and the wheels, by which it is applied to the problem of movement. If we would enlighten the pupil concerning a tree, we direct him first of all to the appropriative and digestive force which constitutes the active principle of life, furnishing from soil and by sunlight the varied material and varied fiber. The leaf, the root, the trunk, the branches, the new seed, follow in their order. With the human body it is the same. I cannot see why it should not be so in the study of mind—that we should not adopt for our order will, intellect, sensibilities.

4. Of the remaining questions which I wish to leave an impression of, one is concerning the possibility of a more scientific arrangement of the sensibilities. Even upon the supposition that all the feelings are but ulterior and elaborated sensations arising in evolutionary order and issuing in so-called naturally determined action, should there not be an organic conception of them? Nature is orderly, and is quite capable of giving an account of herself in the terms of order anywhere. She has no real conglomerates. Especially it is impossible to justify fairly the absence of due logical subordination, to which this most interesting function has been abandoned by those who recognize the moral personality of mind. The traditional classification—simple emotions, affections and desires—has no justification in any organic conception of mental life.

Would it not be worth while to try as a working hypothesis at least, in case mind is free personality under moral law, whether we may not find among the sensibilities some that constitute the appeal of that realm of law to this freely acting personality? It may be—it seems reasonable that it should be—nay, it seems manifest that it is true, that, correlative to the law of the true, under which mind acts in judgment, and the law of beauty, under which the sensibilities are ordered in feeling, and to the dual law of the good, under which the will is responsible in citizenship, there are clearly defined and explained sensibilities which stand as advocates before the free personality to induce the higher and supreme conformity of the will, in loyalty to the good, the beautiful and the true—that ultimate kingdom which is the home and the aspiration of man. If we should find this hypothesis justified, we might call these sensibilities the rectoral sensibilities.

On this general conception of the significance of mind, the classification of the sensibilities may be easily completed. The function of moral citizenship under law having to be performed in relations suitable to the common weal, the environment which they furnish may be expected to be—we should suppose must be—nay, are manifested as being, by whatever law of the survival of the fittest or any other, brought to bear on the personality for adjustment by corresponding forms of feeling. The race, the nation, the family, have their correlated sensibilities, which promote the integrity and permanent maintenance of these relations. These we may call the relational sensibilities.

The individual personality, however, could not be expected to be left without provision in corresponding sensibilities which should guarantee its support. Man is a dual organism in which, whatever explanation we may make of it, is the antithesis of mind and body. Mind and body must be brought into touch, for their support, with the will by forms of sensibility which present their needs to this central personality. There must be the mental and the corporeal appetites, and thus we have a third class of sensibilities which we may well enough call suppeditary sensibilities. Without going into detail and explaining certain forms of sensibility which only seem extraordinate to this classification, would it not be practicable to substitute for the old classification or for none at all, this: The rectoral, the relational, the suppeditary? Certain it is that in the study of mind, whatever view we may take of its place and relation in the kosmos, we are compelled to account upon mind as being a most consummate piece of perfect work. The eye, which detects harmony, is a harmony. The mind that responds to summer sunsets is no jnmble. The wonders of constructive art in lower organic life are outmatched in the structure of the personality. If we cannot say with Hamilton, in the legend over his teacher's desk. "There is nothing great in the universe but man; there is nothing great in man but mind," we can consent to all that the great dramatic poet has said of him, and we can adopt the words of that composite lyric philosopher which sends his plummet deeper than Shakespeare's has gone into wondrous depths of personality: "Thou hast made him little lower than the angels.' Surely the study of psychology has yet conquests to make in the discovery of mental order that are beyond the achievements of the microscope and the section knife of the tyro, who has not yet sounded his own mind's depths and the depths of the great heart of the world and of history. He only who is, through long listening, a seer, is fitted to hear the revelations of this oracle out of the unknown and awful Holy of Holies.

5. Socrates in the Republic is made to say: "ἐπιστήμη is the knowledge, in respect to the reality, that the reality is." Now it is affirmed that "we have numerous sensations and by means of these we acquire ideas. We then assume external objects as the cause of these sensations and ideas. Empirical psychology therefore relegates the further handling of the problem, in so far as it is capable of any solution whatever, to Epistemology." Now I would raise the question whether Epistemology is responsible for giving account of the causes of sensations and ideas any more than it is for certifying the reality of subjective sensations and ideas themselves. Is it any less gratuitous to say that we have sensations and ideas or to entertain a concept of sensations and ideas as being their mental image representing a mental reality, than it is to affirm a cause of our psychic states? If it is not legitimate for empirical psychology to affirm causes of mental states then it is not legitimate for empirical psychology to affirm ideas or sensations. An idea is something, a sensation is something, even though it be merely a phenomenon. The question is, whether in case we have not Epistemology, there can be not only any affirmation of causes, but any trust in the existence of sensations or ideas. Does not a psychology which leaves a lacuna opposite the word *knowledge*, for the same reason leave one opposite the word *reality*, opposite the word *sensation*, opposite the word *therefore*, opposite the word *science?* This only goes so far as to constitute a caveat against making any part of psychology its own verification. Empirical psychology, whether it be constructed by consciousness alone or with the valuable aid of physiology, is a dependent science. It is a natural science—I am quite willing it should be called so, if the human mind be regarded as a part of the fundementally free system of nature and not a part of a supernatural realm, as Dr. Bushnell classes it, and all its phenomena are answerable to the law of sufficient reason and so are verified by Epistemology.

I was intending, however, only to ask the question as to the order of studying the cognitive function of mind. If it is by the exercise of this function that knowledge is had, and the science of knowledge, which is Epistemology, exists, the function itself is a topic of psychology. It has always been a puzzle how to furnish any adequate warrant for the veracity of the senses. Any explanation which can be furnished out of the phenomena of mere sensation by recurring to the coördination and mutual consensus of all the senses is unsatisfying. It is in vain to resort to the Cartesian verification in the veraciousness of a beneficent Creator, for this would involve sooner or later a circle in reasoning. Must we not first find our verifications in the certainties of reason? Does not the significance of the five senses lie in the fact that we have supersense cognition, or reason? It is customary to begin the study of the presentative functions of mind with the subject of sensation and sense-perception, doing as well as we can with the question why we should trust the senses. As for myself, I have found it satisfactory to seek in reason—the supersense cognitive function in its various modes—entrance to the intellectual department of mental study and find there the ground on which to plant the superstructure of perception by sensation. It is only because we have the power of rational knowledge that we have the power of sensing reality. Reason is the only apprehension. Sensation only gives coloring. I would suggest that along this line of procedure—for those who have not surrendered the department of psychology, like others, wholly to agnostic theory—will be found relief from an otherwise unresolved perplexity. There is no ground for believing in a cortical irritation, or in a sensation, or an idea, or for making any judgment or using any predicate, unless there be found first in empirical psychology intimation of a function of rational knowledge. If you can not find it by physiological psychology you must seek it by the psychology of conciousness. If you say there is no other psychology than physiological psychology, your physiological psychology is the futility of the hypothesis of the dream of a dream. Utter skepticism even is a baseless hypothesis which is itself an endless hypothetical series. When we arrive at such a pass we may say with Cicero: "Et mihi ipsi diffidem"—"I do not know which end my head is on."

6. The only other suggestion I have to make is of a doubt whether we have not hitherto done violence to psychology by limiting its range to individual mind. The ancient conception of man as having not only his end but his significance merely as a fraction of the state, against which, in its classic form, Christianity made divine protest, but which corporate Christianity too much yielded to, giving away under the intense materialism of the French revolution period, is, in better form and under better auspices, reasserting itself in this our new period. Ours has been a most beneficent era of the clearing up and differentiating of the individual personality, of which era the French revolution was the criminal evangel. Since that baleful morning of blessing, the individual has happily, by slow and painful and turbulent process, become identified not only out of the classes into which an utterly unsympathetic science had generalized him, but out of the mass of the civic society in which selfish social tyranny had lost him, making him only a cypher for multiplying its own significance. Now that not only the word man has come to mean man, and woman has come to mean woman, but each individual man is revealed in the common consciousness as being his own determinate and significant self, and each woman as being her own determinate and significant self, and in like manner and degree childhood has come to the recognition of his and her significant identity also—a process not altogether completed—a splendid reintegration into a richer integrity of civic society is already putting to us the question whether, as our practical philanthropy and patriotism are asserting the new gospel of organic solidarity, so the science of man

should not reconstitute itself on the same better principles. The question arises, is the psychic man realized in the individual or in society? Is psychology complete when it isolates the individual personality and studies him thus, or should it at least complete its work in maturing the perfect concept of that flood of social purpose, instructed by confluent intelligence and made persuasive by fellowship of heart,—the social personality, which is immeasurably more than the sum of its constituent individualities, even as the living body is the sum of more than all its members and as you have not the oak when you have its root, its trunk, its leaves and its branches which hold them forth to breathe the air of the winds of the mountains? It certainly seems likely that, obeying the widening comprehension of all thought, social psychology will inherit the interest of scholarship not long hence—the empirical science of the social mind.

All things force us to the conclusion, that, while the science of which I have been speaking is reverend with the growth of many years and by the record of many who have been made illustrious in its study and teaching, it has most interesting and momentous inquiries yet for the student to consider—new fields to conquer. Certain it is that, such is the relation of psychology to science as science, no conquests in the field of other sciences can be made settled realms of human possession so that man can call them his and be much greatened and ennobled by their influence, save so far as by this science of the mind the endowments, in whose hands can be found the title deeds of their certain tenure, are disclosed.

ON THE FLORA OF MADISON AND VICINITY, A PRELIMINARY PAPER ON THE FLORA OF DANE COUNTY, WISCONSIN.

BY L. S. CHENEY AND R. H. TRUE.

In its conception, the plan of the work which has resulted in this paper, included merely the formation of a list of the phænogamous flora of Madison and vicinity. As the work progressed, however, the determination of limits became increasingly difficult and it was finally resolved to make the results already obtained the first instalment of a list of the flora of Dane county. It, therefore, follows that the list, fairly complete through the Bryophyta, for the original locality, becomes a rather meager one for the larger area. As it is intended to thoroughly canvass the remaining parts of the county as time may permit, it has seemed best to entitle this paper "a preliminary list," with a request that errors and additions be kindly brought to the notice of the writers.

As environment is so influential in determining the character of the flora of any given region, it has seemed best to preface the consideration of the plant life of the area in question by a brief notice of its topography, geological structure and meteorological conditions.

In drawing up the following account, free use has been made of the descriptions and plates found in the "Geology of Wisconsin,"* especially Vol. II, and those desiring greater local detail than the limits of the subject permit here, are referred to that work.

Dane county occupies a position about midway in the width of the State and its southern boundary is twenty-four miles north of the Illinois state line. It has an area of about 1,238

*Madison, Wis. T. C. Chamberlin, Chief Geologist, Vol. II, 1878. (Roland D. Irving, Associate Geologist for Central Wisconsin.)

square miles. In shape, it is almost a perfect rectangle, the northwest corner being cut off by the Wisconsin river. From north to south, its extent is thirty miles; from east to west, forty-two miles.

Except an area of 120 square miles in the northwestern part, which is drained by the Wisconsin river, Dane county lies in the Rock river basin. The water-shed between these two basins crosses the county in a southwesterly direction, cutting the north and the west lines fifteen miles and thirteen miles, respectively, from their intersections with the Wisconsin. There is maintained, therefore, a valley of approximately regular width. This ridge has an altitude of from 500 to 600 feet above Lake Michigan and a width sometimes equal to a township. Both sides are irregularly eroded, the northern side, especially, being fringed out into long, abrupt headlands. The top is occupied by a prairie belt. Except in the middle third of its course, in the towns of Middleton and Cross Plains, its surface stratum is Lower Magnesian limestone. Here St. Peter's sandstone and Trenton limestone appear. Toward the Wisconsin river the level is broken by outlying patches of high country. The southern slope from this water-shed is much more gradual, more nearly conforming to the slope of the underlying strata.

Although included in the Rock river basin, the remaining part of the county is drained in three different directions by a number of small streams. Chief among these is the Yahara river. The valley occupied by it and the chain of lakes which it connects, forms the central topographical feature of the county. This river, entering from the north, flows south to the middle of the county and empties into the largest and most northern of the lakes. From here a general southeast direction is followed to the point of exit from the county. At varying intervals along its lower course, the river widens to fill cross valleys of various sizes, thus forming the well-known series of lakes. Along this valley as far south as the lowest of these lakes, Potsdam sandstone is the surface stratum, bordered at the sides by Mendota limestone and Madison sandstone (Lower Magnesian). Along the remainder of its course in this county, the surface formations are in general Lower Magnesian limestone with limited areas of Potsdam sandstone. The general altitude of the valley is from 250 to 300 feet above Lake Michigan. The surface is occasionally rather irregular owing to the varying thickness of the drift deposit. This is especially true in the immediate vicinity of Madison.

In the southwestern part of the county, separated from the Yahara valley by a belt of hilly country, is the Sugar river valley. The slope is here almost directly south. The surface formations are principally St. Peter's sandstone, Trenton and Galena limestone frequently occurring in limited areas.

East of the Yahara valley and separated from it by a ridge varying from 240 to 400 feet in altitude above Lake Michigan, is the third drainage area in that portion of the Rock river basin included in Dane county. Here the slope is nearly east with a gentle, undulating descent. In the northern part of this region, Lower Magnesian and Trenton limestone form the surface strata; in the middle area, St. Peter's sandstone prevails, while Trenton limestone forms the greater part of the surface rock in the southern part.

The soil of Dane county is, in general, very fertile, the chief exception being found in the sandy lowlands along the Wisconsin river. Since the soil derives its character to a great degree from the underlying strata, we might expect that the Yahara valley with its Potsdam foundation would also present a sandy soil. On the contrary, drift and alluvial additions have rendered it most productive. In the limestone region the characteristic fertile soil is found.

Although the meteorological observations here quoted were made at Madison, it may be assumed that they hold with sufficient accuracy for the entire county.

The average annual rainfall is about 34.5 inches. The month of least average fall is February; the month of greatest fall, June. The average number of days in which rain or snow falls is 105, so that protracted drouths are very rare.

The mean annual temperature is about 45°F. The maximum summer heat is about 100° and the minimum of winter is abou 26° below zero. Continued severe winter weather is the exception.

The vegetation of the region under consideration varies somewhat with elevation and character of soil. The woods, confined chiefly to the uplands, are made up largely of the oaks, with occasional limited areas characterized by maples, cottonwood or the white elm. The conifers are barely represented by *Larix Americana*, *Juniperus Virginiana* and *Picea nigra.* Generally speaking, the low marshy meadow bordering on the lakes and streams yields chiefly grasses and sedges.

The greater number of the flowering plants and ferns enumerated are quite generally distributed throughout the region, but there are some exceptions worthy of mention. Of the sixteen Orchids listed, but three, *Orchis spectabilis*, *Habenaria bracteata* and *Cypripedium pubescens*, may be regarded as having a general distribution; the others occur in very limited areas only. *Larix Americana* occurs in a swamp near Windsor, in a similar place east of Lake Waubesa and at Hook Lake; *Mitella nuda* and *Trientalis Americana* in the swamps near Windsor just mentioned. So far as has been observed, *Ophioglossum vulgatum* grows in a single locality, a little sandy knoll near the outlet of Lake Wingra. Several introduced species, such as *Salsola Kali*, *Camelina sativa*, *Barbarea vulgaris*, *Arenaria serpyllifolia* and *Veronica arvensis*, are found only along railroads and near towns. Of *Platanus occidentalis*, but a single small specimen was found. This stands at the water's edge on the west shore of Lake Kegonsa midway between the northern and the southern extremities. Of *Gymnocladus Canadensis*, two small trees are growing in the woods near the lake shore east of Winnequah. Most noteworthy of all exceptions is that furnished by Hook Lake. This small sheet of water occupies a basin in the "kettle range" in the southern part of the county and has no outlet. In the lake is a floating bog of several acres extent, and also a high wooded island. On the bog are a few scattered spruces (*Picea nigra*) and a dense undergrowth of *Vaccinium corymbosum.* On the margin of the lake *Vaccinium Pennsylvanicum*, *V. corymbosum*, *Pyrus arbutifolia*, var. *melanocarpa*, *Spiræa tomentosa* and *Betula papyrifera* were collected.

Another peat bog of a somewhat similar character of smaller area is found in the most southeast section of the town of Madison. Here *Sphagna* are found in abundance along with the flowering plants characteristic of such regions.

Of the 729 flowering plants here listed, 626 are indigenous to Wisconsin. These, with the exception of nine species, are natives of Dane county and of the special portion of it under consideration as well. Of the 103 introduced species, *Salsola Kali* came from the eastern states; *Robinia pseudacacia*, *Mollugo verticillata*, *Helianthus annuus*, *Phlox paniculata* and *Tecoma radicans* from the middle and southern states; *Ipomœa purpurea*, *Amarantus retroflexus* and *Chenopodium ambrosoides*, var. *anthelminticum* from tropical America; *Æsculus Hippocastanum* from Asia; and *Abutilon Avicennæ* and *Polygonum Orientale* from India. The remaining ninety-one are European. Probably sixty of the introduced species have been cultivated as plants useful to man. *Salsola Kali* and *Mollugo verticillata* are American weeds that are becoming widely distributed, though not especially troublesome. The remaining forty-one have come to us unbidden as the accompaniments of immigration and importation from foreign lands and include most of our troublesome weeds.

The moss flora (including the liverworts) of Madison and vicinity is not especially rich. The absence of the most favorable conditions, such as pine or dense hard wood forests and peat bogs, together with the general cultivation of the soil, conspire to keep out or drive out many forms that otherwise might be expected in this latitude. The lack of the necessary moisture on the rock exposures about the lakes prevents the growth of many forms occurring in damper spots in the southern part of the State.

Of the 150 species and varieties identified, fifteen are liverworts, distributed as follows: *Jungermanniaceæ*, five; *Anthocerotaceæ*, two; *Marchantiaceæ*, five; and *Ricciaceæ*, three. The remaining 135 include forty-three *Hypnums*, ten *Dicranums*, eight *Bryums*, five *Polytrichums*, six *Orthotrichums*, four *Mniums* and fifty-nnie species distributed among thirty-one genera, not more than three species occurring in any one genus. Among forms of rare or of local occurrence, the following may be noted: *Pylaisœa subdenticulata*, *P. polyantha*, *Leskea Aus-*

tini, *Hypnum irriguum*, var. *spinifolium*, *H. acutum*, *H. compactum*, *H. filicinum*, *Desmatodon arenaceus*, *Barbula fallax*, *Gymnostomum calcareum*, *G. rupestre*, *Philonotis calcarea*, *Cylindrothecium compressum*, *Dicranum viride*, *D. Bonjeani*, vars *alatum* and *Schlotthaueri*, *Grimmia Donniana*, *G. plagiopodia*, *Mnium rostratum*, *M. serratum* and *Sphagnum molle*.

The list of plants included in this paper is the result of the work of three seasons. During that time fully five thousand specimens have been examined. All plants admitted to this list have passed through the hands of the authors; therefore, they only are responsible for errors.

On account of lack of time during the early part of the season it has been impossible to make a systematic study of the difficult genus, *Salix*. It is expected to give to it a thorough study during the coming season and a report upon it will be made in a later paper.

For the convenience of collectors and others to whom it will be of use, a map of Madison and vicinity is included with the list. It is based on the topographical atlas sheets of the United States Geological Survey and has been brought up to date in regard to roads. It is hoped that it may serve as a practical field guide to collectors.

In nomenclature the sixth edition of Gray's Manual has been followed in all cases. The reason for so doing has been that of convenience, as this is the manual most in use here.

In general arrangement we have followed the same work with a few exceptions. For PHANEROGAMIA, the term SPERMAPHYTA has been used. The GYMNOSPERMÆ have been placed between the MONOCOTYLEDONES and the PTERIDOPHYTA. In the minor details of classification the manual has been followed in all particulars. We again make convenience the reason for so doing without thereby expressing any opinion of our own.

At the suggestion of Dr. Edward Kremers, of the Pharmaceutical Department of the University of Wisconsin, we have indicated, for the convenience of students of Pharmacy, the medicinal plants occurring in this region. We have designated the unofficinal medicinal plants by one asterisk before the name of each, and those officinal by two asterisks. Whenever the name by which a plant is known in the United States Dispensatory differs from that given in the last edition of Gray's Manual, the former is quoted in parenthesis as a synonym of the latter. As a basis for comparison we have used the third edition of the Dispensatory and the sixth edition of Gray's Manual.

In the preparation of this list we have received much kind aid. Grateful acknowledgments are due to Dr. Charles R. Barnes, of the University of Wisconsin, for assistance rendered in the determination of the more difficult species of mosses; to Dr. L. M. Underwood, of the University of Texas, for the indentification of liverworts; to Dr. C. Warnstorf, of Neu Ruppin, Prussia, for the determination of mosses belonging to the genus *Sphagnum;* to Dr. Charles Morong, of Columbia College, and to Dr. Stanley Coulter, of Purdue University, for the determination of difficult species of flowering plants.

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MADISON, WIS., January 27, 1893.

SPERMAPHYTA.

ANGIOSPERMÆ.

POLYPETALÆ.

DICOTYLEDONES.

RANUNCULACEÆ (CROWFOOT FAMILY.)

CLEMATIS, L. Virgin's bower.

1. **C. Virginiana*, L. Common virgin's bower.
Not rare along the shores of the lakes.

ANEMONE, L. Windflower.

2. ****A. patens*, L. var. *Nuttaliana*, Gray. Pasque-flower.
Rocky and gravelly hills west and south of Madison. Local.

3. *A. cylindrica*, Gray. Long-fruited anemone.
Occasional throughout the region.

4. *A. Virginiana*, L.
Commoner than *A. cylindrica*. Of same range.

5. *A. Pennsylvanica*, L.
Common.

6. **A. nemorosa*, L. Wood anemone. Wind-flower.
On open-wooded hillsides. Not rare.

HEPATICA, Dill. Liver-leaf. Hepatica.

7. **H. triloba*, Chaix.
Occurring much more rarely than the following. In similar localities.

8. **H. acutiloba*, DC.
This species, with *H. triloba*, is still found on the wooded north slopes about the lakes, but gradually disappearing as the locations are improved.

ANEMONELLA, Spach.

9. *A. thalictroides*, Spach. Rue-anemone.
Wooded pasture south of Madison. Local.

THALICTRUM, Tourn. Meadow-rue.

10. *T. dioicum*, L. Early meadow-rue.
Rich woods. Common.

11. *T. purpurascens*, L. Purplish meadow-rue.
Dry uplands. Common.

RANUNCULUS, L. Crowfoot. Buttercup.

12 *R. aquatilis*, L. var. *trichophyllus*, Gray.
Common in the shallower parts of the lakes and in sluggish streams.

13. *R. multifidus*, Pursh. Yellow water-crowfoot.
Common throughout the region.

14. *R. rhomboideus*, Goldie.
Thinly wooded uplands south of Madison.

15. *R. abortivus*, L. Small-flowered crowfoot.
Common everywhere.

16. **R. sceleratus*, L. Cursed crowfoot.
Common in wet land that has been cultivated or broken.

17. *R. recurvatus*, Poir. Hooked crowfoot.
Of occasional occurrence throughout the region.

18. *R. fascicularis*, Muhl. Early crowfoot.
Common on dry hillsides.

19. *R. septentrionalis*, Poir.
Distributed throughout regicn. Not abundant.

20. **R. repens*, L.
Same distribution as *R. septentrionalis*. Much rarer.

21. *R. Pennsylvanicus*, L. f. Bristly crowfoot.
Common in low wet lands.

ISOPYRUM, L.

22. *I. biternatum*, Torr. & Gray.
Lakes Wabesa and Kegonsa. Local

CALTHA, L. Marsh marigold.

23. *C. palustris*, L.

Common throughout the region.

AQUILEGIA, Tourn. Columbine.

24. *A. Canadensis*, L. Wild columbine.

On rocky bluffs around the lakes.

ACTÆA, L. Baneberry. Cohosh.

25. **A. spicata*, L., var. *rubra*, Ait. Red baneberry (*A. rubra*, Bigelow.)

Throughout the region in rich woods.

MENISPERMACEÆ. (MOONSEED FAMILY.)

MENISPERMUM, L. Moonseed.

26. ***M. Canadense*, L.

Not rare along shores of lakes.

BERBERIDACEÆ. (BARBERRY FAMILY.)

BERBERIS, L. Barberry.

27. *B. VULGARIS, L.

North of Lake Wingra. Wingra Park. May be looked for elsewhere near dwellings. Escaped from cultivation.

CAULOPHYLLUM, Michx. Blue cohosh.

28. **C. thalictroides*, Michx. Papoose-root.

Met with occasionally throughout the region.

PODOPHYLLUM, L. May-apple. Mandrake.

29. ***P. peltatum*, L.

Common.

NYMPHÆACEÆ. (WATER-LILY FAMILY.)

BRASENIA, Schreber. Water-shield.

30. *B. peltata*, Pursh.

Lake Wingra. Hook Lake. Local

NYMPHÆA, Tourn. Water-nymph. Water-lily.

31. *N. reniformis*, DC.!

This is our common white water-lily. Abundant in the shallow bays of all our lakes and in the streams emptying into them.

NUPHAR, Smith. Yellow pond-lily. Spatter-dock.

32. **N. advena*, Ait. f.

Common. Of same range as *Nymphæa reniformis.*

SARRACENIACEÆ. (PITCHER-PLANT FAMILY.)

SARRACENIA, Tourn. Side-saddle flower.

33. **S. purpurea*, L. Pitcher-plant. Huntsman's cup.

Found occasionally in marsh land south of Lakes Monona and Wingra, and east of Lake Wabesa.

PAPAVERACEÆ. (POPPY FAMILY.)

SANGUINARIA, Dill. Blood-root.

34. ***S. Canadensis*, L.

Found throughout the region. Rather local in its occurrence.

FUMARIACEÆ. (FUMITORY FAMILY.)

DICENTRA, Borkh. Dutchman's breeches.

35. *D. Cucullaria*, DC.

Common.

36. **D. Canadensis*, DC. Squirrel corn.

Two specimens found by E. B. Copeland on Governor's Island growing with *D. cucullaria.* Rare.

CORYDALIS, Vent.

37. *C. glauca*, Pursh. Pale corydalis.

Ridge northeast of Lake Wingra. Rare.

CRUCIFERÆ. (MUSTARD FAMILY.)

DENTARIA, Tourn. Toothwort. Pepper-root.

38. **D. laciniata*, Muhl.

Common in rich woods throughout the region

CARDAMINE, Tourn. Bitter-cress.

39. *C. rhomboidea*, DC. Spring cress.
Common in marshy pasture land.

ARABIS, L. Rock cress.

40. *A. hirsuta*, Scop.
Rocky bluffs about the lakes. Not common.

41. *A. confinis*, Watson.
Dry hills. Local.

42. **A. lyrata*, L.
Growing on rocky or gravelly points. Local.

43. *A. dentata*, Torr. & Gray.
Rich woodlands. Not abundant.

DRABA, Dill. Whitlow-grass.

44. *D. Caroliniana*, Watt.
Growing on sandy ridges and slopes about the lakes. Local.

CAMELINA, Crantz. False flax.

45. *C. SATIVA, Crantz.
Found occasionally along railroad tracks. Not common. Introduced.

NASTURTIUM, R. Br. Water-cress.

46. *N. OFFICINALE, R. Br. True water-cress.
Common in all springs and spring branches in the region.

47. **N. palustre*, DC. Marsh cress.
Found with *N. officinale.* Not common.

48. *N. ARMORACIA, Fries. Horseradish. (*Cochlearia Armoracia*, L.)
Throughout the region. Becoming very abundant in some places. Escaped from cultivation.

BARBAREA, R. Br. Winter cress.

49. *B. VULGARIS, R. Br. Common winter cress. Yellow rocket.
Found growing near the Fuller and Johnson Plow Works in the eastern part of the city of Madison. Introduced.

ERYSIMUM, Tourn. Treacle mustard.

50. *E. parviflorum*, Nutt.
Picnic Point, Madison. Rare.

SISYMBRIUM, Tourn. Hedge mustard.

51. *S. canescens*, Nutt. Tansy mustard.
Sandy shores of Lakes Monona, Wabesa and Wingra. Rare.

52. *S. OFFICINALE, Scop. Hedge mustard.
Common throughout the region.

BRASSICA, Tourn.

53. *B. SINAPISTRUM, Boiss. Charlock.
Throughout the region. Abundant. Commonly known here as "black mustard."

54. *B. NIGRA, Koch. Black mustard.
Observed in two places in the city of Madison and west of the city near an old dwelling. To be looked for elsewhere. Introduced.

CAPSELLA, Medic. Shepherd's purse.

55. *C. BURSA-PASTORIS, Moench.
Everywhere as a weed.

LEPIDIUM, Tourn. Pepperwood. Peppergrass.

56. **L. Virginicum*, L. Wild peppergrass.
Common throughout the region.

CAPPARIDACEÆ. (CAPER FAMILY.)

POLANISIA, Raf.

57. P. GRAVEOLENS, Raf.
Growing occasionally along railroads. Introduced. Rare.

CISTACEÆ. (ROCK-ROSE FAMILY.)

HELIANTHEMUM, Tourn. Rock-rose.

58. **H. Canadense*, Michx. Frost-weed.
Common in dry thickets and pasture land.

VIOLACEÆ. (VIOLET FAMILY.)

VIOLA, Tourn. Violet. Heart's-ease.

59. *V. *pedata*, L. Birdfoot violet.
Common throughout region on dry, rocky or gravelly points.

60. V. *pedatifida*, G. Don.
Distribution the same as that of *V. pedata.* Not so common and on better soil.

61 V. *palmata*, L. Common blue violet.
Same range as *V. pedatifida.* Not common.

62. *V. *palmata*, L., var. *cucullata*, Gray. (*V. cucullata* Ait.)
Everywhere. The common violet of southern Wisconsin.

63. V. *sagittata*, Ait. Arrow-leaved violet.
Dry wooded hills. Local.

64. V. *blanda*, Willd. Sweet white violet.
Growing at the base of trees and clumps of shrubs in wet woodlands about the lakes. Local.

65. V. *blanda*, Willd., var. *palustriformis*, Gray.
Found occasionally with *V. blanda.* Not common.

66. V. *pubescens*, Ait. Downy yellow violet.
Common in rich woodlands throughout the region.

67. V. *canina*, L., var. *Muhlenbergii*, Gray. Dog violet.
Edge of marsh south of Lake Wingra. Not observed elsewhere.

CARYOPHYLLACEÆ. (PINK FAMILY.)

SAPONARIA, L.

68. *S. OFFICINALIS, L. Soapwort. Bouncing Bet.
Escaped from cultivation. Common along roadsides near dwellings.

SILENE, L. Catchfly. Campion.

69. S. *stellata*, Ait. Starry campion.
Found growing in a few places in rich woods near

70. *S. antirrhina*, L. Sleepy campion.
Not uncommon in dry, sandy places. Local.

71. S. NOCTIFLORA, L. Night-flowering campion.
Observed in three or four places in the city of Madison. Not common.

LYCHNIS, Tourn. Cockle.

72. L. GITHAGO, Lam. Corn cockle.
Widely distributed, though not abundant, in grain fields and along railroads.

ARENARIA, L. Sandwort.

73. A. SERPYLLIFOLIA, L. Thyme-leaved sandwort.
Abundant on sandy shore of Lake Monona east of Elmside addition, Madison; also along west bank of Yahara river at Stoughton.

74. *A. Michauxii*, Hook. f.
Dry rocky hills about Madison.

75. *A. lateriflora*, L
Common.

STELLARIA, L. Chickweed. Starwort.

76. S. MEDIA, Smith. Common chickweed.
Common.

77. *S. crassifolia*, Ehrh.
Collected on north side of University bay. Lake Mendota.

CERASTIUM, L. Mouse-ear chickweed.

78. C. VISCOSUM, L. Mouse-ear chickweed.
Collected on east shore of Lake Mendota. Not common.

79. C. VULGATUM, L. Larger mouse-ear chickweed.
Common.

PORTULACACEÆ. (PURSLANE FAMILY.)

PORTULACA, Tourn. Purslane.

80. P. OLERACEA, L. Common purslane.
Common in cultivated grounds as a weed.

CLAYTONIA, Gronov. Spring beauty.

81. *C. Virginica*, L.
In rich woods. Local.

HYPERICACEÆ. (ST. JOHN'S-WORT FAMILY.)

HYPERICUM, Tourn. St. John's-wort.

82. *H. maculatum*, Walt.
Occurring occasionally in low grassy places.

83. *H. mutilum*, L.
15 to 20 stamens! Common.

ELODES, Adans. Marsh St. John's-wort.

84. *E. campanulata*, Pursh.
Not uncommon in the low lands about the lakes.

MALVACEÆ. (MALLOW FAMILY.)

MALVA, L. Mallow.

85. *M. ROTUNDIFOLIA, L. Common mallow.
Common along roadsides in waste places and cultivated grounds.

86. *M. SYLVESTRIS, L. High mallow.
Persisting occasionally after cultivation.

ABUTILON, Tourn. Indian mallow.

87. *A. AVICENNÆ, Gaertn. Velvet-leaf.
A weed in cultivated land. Not very abundant.

HIBISCUS, L. Rose mallow.

88. H. TRINONUM, L. Bladder Ketmia.
Occasionally escaping from cultivation.

TILIACEÆ. (LINDEN FAMILY.)

TILIA, Tourn. Linden. Basswood.

89. **T. Americana*, L. Basswood.
Not uncommon about the lakes and along the streams.

LINACEÆ. (FLAX FAMILY.)

LINUM, Tourn. Flax.

90. *L. sulcatum*, Riddell.
Collected on a rocky point at Burke. Rare.

91. **L. USITATISSIMUM, L. Common flax.
Common along railroads.

GERANIACEÆ. (GERANIUM FAMILY.)

GERANIUM, Tourn. Cranesbill.

92.** *G. maculatum*, L. Wild cranesbill.
Common in all the woods and thickets of the region.

OXALIS, L. Wood-sorrel.

93. *O. violacea*, L. Violet wood-sorrel.
Common on sandy or gravelly soil.

94. **O. corniculata*, L., var. *stricta*, Sav. Yellow wood-sorrel. (*O. stricta*, L.)
Growing everywhere.

IMPATIENS, L. Balsam. Jewel-weed.

95. *I. pallida*, Nutt. Pale touch-me-not.
Occasionally met with in rich woodlands. Rare.

96. *I. fulva*, Nutt. Spotted touch-me-not.
Abundant about the lakes and in wet places.

RUTACEÆ. (RUE FAMILY.)

XANTHOXYLUM, L. Prickly ash.

97.**X. *Americanum*, Mill. Northern prickly ash. Tooth-ache tree.
Found occasionally in dry woods.

ILICINEÆ. (HOLLY FAMILY.)

ILEX, L. Holly.

98.**I. *verticillata*, Gray. Black alder. Winterberry.
Along the borders of marshes and ponds. Local.

CELASTRACEÆ. (STAFF-TREE FAMILY.)

CELASTRUS, L. Staff-tree. Shrubby bitter-sweet.

99. **C. scandens*, L. Wax-work. Climbing bitter-sweet.
Ridge northeast of Lake Wingra. In woods along south shore of Lake Mendota. Rare.

RHAMNACEÆ. (BUCKTHORN FAMILY.)

CEANOTHUS, L. New Jersey tea. Red-root.

100. **C. Americanus*, L. New Jersey tea.
Throughout the region on the high land.

VITACEÆ. (VINE FAMILY.)

VITIS, Tourn. Grape.

101. **V. riparia*, Michx.

Common in all thickets and along water courses in woods.

AMPELOPSIS, Michx. Virginian creeper.

102. **A. quinquefolia*, Michx.

Not uncommon. Having same distribution as *Vitis riparia* and growing with it.

SAPINDACEÆ. (SOAPBERRY FAMILY.)

ÆSCULUS, L. Horse-chestnut. Buckeye.

103. *A. HIPPOCASTANUM, L. Common horse-chestnut.

Growing in lawns as an ornamental tree in Madison.

ACER, Tourn. Maple.

104. *A. saccharinum*, Wang. Sugar or rock maple.

In some localities forming a large element of the woods. In others of rather rare occurrence.

105. *A. dasycarpum*, Ehrh. White or silver maple.

The soft maple commonly used in this region as a shade or ornamental tree.

106. *A. rubrum*, L. Red or swamp maple.

Occasionally used as an ornamental tree. In the low wet woodlands about the lakes.

107. A. PLATANOIDES, L. Norway maple.

An ornamental tree on University campus and in Capitol park.

NEGUNDO, Moench. Ash-leaved maple. Box-elder.

108. *N. aceroides*, Moench.

Often planted along Madison streets. Occasionally wild in the woods about the lakes.

STAPHYLEA, L. Bladder-nut.

109. *S. trifolia*, L. American bladder-nut.

University campus near pump house. Rare.

ANACARDIACEÆ. (CASHEW FAMILY.)

RHUS, L. Sumach.

110. **R. typhina*, L. Staghorn sumach.
Common.

111. ***R. glabra*, L. Smooth sumach.
Common.

112. ***R. Toxicodendron*, L. Poison ivy. Poison oak.
Not uncommon in thickets. Often confused with *Ampelopsis quinquefolia;* from which, however, it may readily be distinguished by the number and form of its leaflets. In *R. Toxicodendron* the leaf is composed of three unsymmetrical leaflets, while in *A. quinquefolia* there are five symmetrical ones.

POLYGALACEÆ. (MILKWORT FAMILY.)

POLYGALA, Tourn. Milkwort.

113. ***P. Senega*, L. Seneca snake-root.
On dry hillsides. Not common.

114. **P. sanguinea*, L.
Common in low cultivated land.

115. *P. verticillata*, L.
Common on dry points.

LEGUMINOSÆ. (PULSE FAMILY.)

BAPTISIA, Vent. False indigo.

116. *B. leucantha*, Torr. & Gray.
On gravelly hills south of Madison. Not uncommon.

LUPINUS, Tourn. Lupine.

117. **L. perennis*, L. Wild lupine.
Common.

TRIFOLIUM, Tourn. Clover. Trefoil.

118. T. PRATENSE, L. Red clover.
Largely cultivated. Escaped to roadsides and waste places.

119. *T. repens*, L. White clover.
Common everywhere.

120. T. HYBRIDUM, L. Alsike clover.
Not rare with *T. repens.* Becoming more abundant.

121. T. PROCUMBENS, L. Low hop clover.
Observed in a few places about Madison. Doubtless introduced with other clovers.

MELILOTUS, Tourn. Melilot. Sweet clover.

122. *M. OFFICINALIS, Willd. Yellow melilot.
Occurring occasionally with M. ALBA.

123. *M. ALBA, Lam. White melilot.
Common along roadsides and in waste grounds.

MEDICAGO, Tourn. Medick.

124. *M. SATIVA, L. Lucerne. Alfalfa.
Escaped from cultivation and becoming established in a few places about Madison.

125. M. LUPLINA, L. Black medick.
Observed near the University and in two places northeast of Madison along the Portage line of the C. M. & St. P. R. R.

AMORPHA, L. False Indigo.

126. *A. canescens*, Nutt. Lead-plant.
Throughout the region in dry soil.

PETALOSTEMON, Michx. Prairie clover.

127. *P. violaceus*, Michx. Violet prairie clover.
Common on rocky points and along railroads.

128. *P. candidus*, Michx. White prairie clover.
With *P. violaceus*, but not so common.

ROBINIA, L. Locust tree.

129. *R. PSEUDACACIA, L. Common locust-tree or false acacia.
Common in cultivation as an ornamental tree. Persisting in many places about old dwellings.

ASTRAGALUS, Tourn. Milk vetch.

130. *A. Canadensis*, L.
Growing beside the road west of Madison. Rare.

DESMODIUM, Desv. Tick-trefoil.

131. *D. acuminatum*, DC.
In rich open woods. Common.

132. *D. canescens*, DC.
Common along railroads and in thickets.

133. *D. Canadense*, DC.
With *D. canescens*.

LESPEDEZA, Michx. Bush clover.

134. *L. capitata*, Michx.
On dry soil. Not uncommon.

VICIA, Tourn. Vetch. Tare.

135. V. SATIVA, L. Common vetch or tare.
Along railroads and in thickets. Not abundant.

136. *V. Caroliniana*, Walt.
Low rich thickets. Common.

137. *V. Americana*, Muhl.
Moist ground.

LATHYRUS, Tourn. Vetchling. Everlasting pea.

138. *L. ochroleucus*, Hook.
Hillsides. Not uncommon.

139. *L. venosus*, Muhl.
Along railroads and in thickets; very abundant sometimes covering the ground so completely as to keep out all other vegetation.

140. *L. palustris*, L.
Everywhere in wet meadow land.

141. *L. palustris*, L., var. *myrtifolius*, Gray.
With *L. palustris*, but much rarer.

APIOS, Boerhaave. Ground-nut. Wild bean.

142. *A. tuberosa*, Moench.
Observed at half a dozen places near Madison at the margin of pond or lake. Local.

AMPHICARPÆA, Ell. Hog pea-nut.

143. *A. monoica*, Nutt.
Common in all the woodlands of the region

144. *A. Pitcheri*, Torr. & Gray.
With *A. monoica* and almost as common.

GYMNOCLADUS, Lam. Kentucky coffee-tree.

145. *G. Canadensis*, Lam.
Two trees growing near shore of Lake Monona at Winnequah. Rare.

GLEDITSCHIA, L. Honey-locust.

146. *G. triacanthos*, L. Three-thorned acacia. Honey locust.
Beside the road south of Lake Monona. Beside the road near Hook Lake, and in a lawn at the west end of Lake Wingra. Rare.

ROSACEÆ. (ROSE FAMILY.)

PRUNUS, Tourn. Plum, cherry, etc.

147. *P. Americana*, Marshall. Wild yellow or red plum.
Common.

148. *P. pumila*, L. Dwarf cherry. Sand cherry.
High rocky point near head of Pheasant Branch. Similar place west of Madison. Rare.

149. *P. Pennsylvanica*, L. f. Wild red cherry.
West shore of Lake Kegonsa. Rare.

150.***P. Virginiana*, L. Choke cherry.
Common about the lakes.

151***P. serotina*, Ehrh. Wild black cherry.
Occasionally met with in all rich woods throughout the region.

SPIRÆA, L. Meadow-sweet.

152. *S. salicifolia*, L. Common meadow-sweet.
Low wet meadows and marshes; rather scarce.

153. **S. tomentosa*, L. Hardhack. Steeplebush.
Hook Lake. Rare.

RUBUS, Tourn. Bramble.

154. *R. triflorus*, Richardson. Dwarf raspberry.
In low wet grove south of Madison near Lake Wingra. Not common.

155. **R. strigosus*, Michx. Wild red raspberry.
Common in waste places.

156. **R. occidentalis*, L. Black raspberry. Thimbleberry.
Along roadsides and old fences.

157.***R. villosus*, Ait. Common or high blackberry.
Common everywhere.

158.***R. Canadensis*, L. Low blackberry. Dewberry.
With *R. villosus*. Less common.

GEUM, L. Avens.

159. *G. album*, Gmelin.
In open woods. Not common.

160. *G. strictum*, Ait.
Moist meadows. Not uncommon.

FRAGARIA, Tourn. Strawberry.

161. *F. Virginiana*, Mill.
Common and abundant everywhere.

162. *F. Virginiana*, Mill., var. *Illinoensis*, Gray.
With the species. Less common.

163. *F. vesca*, L.
Dry rocky slopes. Not rare, though less abundant than *F. Virginiana*.

POTENTILLA, Cinque-foil. Five-finger.

164. *P. arguta*, Pursh.
Throughout the region on dry soil.

165. *P. Norvegica*, L.
Same distribution as *A. arguta*, in similar places, and much more abundant.

166. **P. argentea*, L. Silvery cinque-foil.
Along shore of Lake Mendota east of Eagle's Nest. Rare.

167. **P. palustris*, Scop. Marsh five-finger.
In the marshes about the lakes. Not very abundant and rarely flowering here.

168. **P. Canadensis*, L. Common cinque-foil or five-finger.
Common in dry soil throughout region.

AGRIMONIA, Tourn. Agrimony.

169. *A. *Eupatoria*, L. Common agrimony.
Common in all woodlands.

ROSA, Tourn. Rose.

170. *R. blanda*, Ait.
Along railroads and on rocky places. Common.

PYRUS, L. Pear. Apple.

171. *P. coronaria*, L. American crab-apple.
Distributed throughout the region.

172. *P. arbutifolia*, L. f., var. *melanocarpa*, Hook.
Hook Lake. Rare.

173. *P. AMERICANA, DC. American mountain-ash.
Introduced from northern part of state in many places as an ornamental tree.

CRATÆGUS, L. Hawthorn. White thorn.

174. *C. tomentosa*, L.
Throughout the region. Not so common as the following species.

175. *C. coccinea*, L.
Common throughout the region.

AMELANCHIER, Medic. June berry.

176. *A. Canadensis*, Torr. & Gray. Shad-bush. Service berry.
West shore of Lake Kegonsa. Not common.

177. *A. Canadensis*, Torr. & Gray, var. *oblongifolia*, Torr. & Gray.
Common in low moist grounds.

SAXIFRAGACEÆ. (SAXIFRAGE FAMILY.)

SAXIFRAGA, L. Saxifrage.

178. *S. Pennsylvanica*, L. Swamp saxifrage.
Everywhere in wet meadow lands and marshes.

MITELLA, Tourn. Mitre-wort. Bishop's-cap.

179. *M. nuda*, L.
In small tamarack swamp near Windsor. Rare.

HEUCHERA, L. Alum-root.

180. *H. hispida*, Pursh.
Not rare about the lakes.

PARNASSIA, Tourn. Grass of Parnassus.

181. *P. Caroliniana*, Michx.
Wet meadows. Common.

RIBES, L. Currant. Gooseberry.

182. *R. Cynosbati*, L.
In open woodlands and pastures. Very common

183. *R. gracile*, Michx. Missouri gooseberry.
Having distribution of *R. Cynosbati*. Common.

184. *R. floridum*, L'Her. Wild black currant.
In rich open woods. Not common.

185. *R. rubrum*, L., var. *subglandulosum*, Maxim. Red currant.
Near Madison in two or three places. Not common.

CRASSULACEÆ. (ORPINE FAMILY.)

PENTHORUM, Gronov. Ditch stone-crop.

186. *P. sedoides*, L.
Common in wet places.

SEDUM, Tourn. Stone-crop. Orpine.

187. *S. TELEPHINUM, L. Garden orpine. Live-forever.
Escaped from cultivation and persisting about old dwellings.

HALORAGEÆ. (WATER-MILFOIL FAMILY.)

MYRIOPHYLLUM, Vaill. Water-milfoil.

188. *M. spicatum*, L.
Common in all the lakes.

PROSERPINACA, L. Mermaid-weed.

189. *P. palustris*, L.
Low lands west of Lake Wabesa. Local.

HIPPURIS, L. Mare's tail.

190. *H. vulgaris*, L.
In springs south of Lake Wingra. Rare

CALLITRICHE, L. Water star-wort.

191. **C. verna*, L.
Low land east of Lake Monona. Local.

LYTHRACEÆ. (LOOSESTRIFE FAMILY.)

LYTHRUM, L. Loosestrife.

192. *L. alatum*, Pursh.
Not infrequent in wet meadows about the lakes.

DECODON, Gmel. Swamp loosestrife.

193. *D. verticillatus*, Ell.
Occurring occasionally about the margins of the lakes. Rare.

ONAGRACEÆ. (EVENING-PRIMROSE FAMILY.)

LUDWIGIA, L. False loosestrife.

194. *L. polycarpa*, Short & Peter.
Growing in low wet places and at margins of ponds. Not rare.

195. *L. palustris*, Ell. Water purslane.
In places similar to those in which *L. polycarpa* are found. Less common.

EPILOBIUM, L. Willow-herb.

196. **E. angustifolium*, L. Great willow-herb. Fire-weed.
A few plants found beside railroad south of Madison. West of Lake Wingra. Rare.

197. *E. lineare*, Muhl.
Low lands about the lakes.

198. *E. coloratum*, Muhl.
Common in low lands.

199. *E. adenocaulon*, Haussk.
Common in low lands in 5th ward, Madison.

200. *E. Hornemanni*, Reichenb.
Wet sandstone faces near Black Hawk's cave, Lake Mendota. Dr. Stanley Coulter kindly verified this determination.

ŒNOTHERA, L. Evening primrose.

201. **Œ. biennis*, L. Common evening primrose.
Common.

202. *Œ. pumila*, L.
Occasionally found in low land. Rare.

CIRCÆA, Tourn. Enchanter's nightshade.

203. *C. Lutetiana*, L.
Common in rich woods.

CUCURBITACEÆ. (GOURD FAMILY.)

SICYOS, L. One-seeded bur-cucumber.

204. *S. angulatus*, L.
Growing about the lakes. Not rare.

FICOIDEÆ.

MOLLUGO, L. Indian chickweed.

205. M. VERTICILLATA, L. Carpet-weed.
Sandy places. Not common.

UMBELLIFERÆ. (PARSLEY FAMILY.)

PASTINACA, L. Parsnip.

206. P. SATIVA, L.
Escaped from cultivation and maintaining itself everywhere as a weed.

POLYTÆNIA, DC.

207. *P. Nuttallii*, DC.
Dry hillsides. Rare.

PIMPINELLA, L.

208. *P. integerrima*, Benth & Hook.
Dry sandy soil. Widely distributed.

CRYPTOTÆNIA, DC. Honewort.

209. *C. Canadensis*, DC.
Rich woods. Rather common.

SIUM, Tourn. Water parsnip.

210. **S. circutæfolium*, Gmelin. (*S. lineare*, Michx.)
Common in marshy land.

CICUTA, L. Water hemlock.

211. **C. maculata*, L. Spotted cowbane. Musquash root. Beaver-poison.
About the lakes and along streams. Occasional. A deadly poison; the "wild parsnip" of most cases of poisoning.

212. *C. bulbifera*, L.
In wet meadow land and marshes, abundant.

OSMORRHIZA, Raf. Sweet cicely.

213. *O. brevistylis*, DC.
In rich woods. Not common.

214. *O. longistylis*, DC.
Having same distribution as *O. brevistylis*.

ERYNGIUM, Tourn. Eryngo.

215. **E. yuccæfolium*, Michx. Rattlesnake-master. Button snake root.
On dry hills along railroads. Not common.

SANICULA, Tourn. Sanicle. Black snakeroot.

216. **S. Marylandica*, L.
Open woods. Common.

ARALIACEÆ. (GINSENG FAMILY.)

ARALIA, Tourn. Ginseng. Wild sarsaparilla.

217. **A. racemosa*, L. Spikenard.
In rich woods. Widely distributed.

218. **A. nudicaulis*, L. Wild sarsaparilla.
Rich woodlands. Not rare.

219. **A. quinquefolia*, Decsne & Planch. Ginseng.
Occasional in rich woods. Becoming rather rare.

CORNACEÆ. (DOGWOOD FAMILY.)

CORNUS, Tourn. Cornel. Dogwood.

220. *C. Canadensis*, L. Dwarf cornel. Bunch berry.
Found east of Lake Monona about one mile. Rare.

221. **C. sericea*, L. Silky cornel. Kinnikinnik.
Growing along watercourses and at the margins of ponds. Not common.

222. *C. stolonifera*, Michx. Red-osier dogwood.
Having same distribution as *C. sericea*. Common.

223. *C. paniculata*, L'Her. Panicled cornel.
On upland in open woods and thickets.

224. *C. alternifolia*, L. f.
Observed in Fuller's woods east of Madison. Rare.

GAMOPETALÆ.

CAPRIFOLIACEÆ. (HONEYSUCKLE FAMILY.)

SAMBUCUS, Tourn. Elder.

225.***S. Canadensis*, L. Common elder.
Everywhere. Common.

VIBURNUM, L. Arrow-wood. Laurestinus.

226. **V. Opulus*, L. Cranberry-tree.
Low wet thickets. Not rare.

227. *V. dentatum*, L. Arrow-wood.
Rocky woodlands. Rather local.

228. *V. Lentago*, L. Sweet viburnum. Sheep-berry.
Woods throughout the region. Not common.

229.***V. prunifolium*, L. Black haw.
Common along streams and at the margins of ponds and marshes.

TRIOSTEUM, L. Feverwort. Horse-gentian.

230. **T. perfoliatum*, L.
Rich woodlands. Widely distributed.

LINNÆA, Gronov. Twin-flower.

231. *L. borealis*, Gronov.
One mile north of Mendota. Rare.

SYMPHORICARPOS, Dill. Snowberry.

232. S. VULGARIS, Michx. Indian currant. Coral-berry.
Occasionally escaped from cultivation.

LONICERA, L. Honeysuckle. Woodbine.

233. *L. glauca*, Hill.
Rich woodlands. Not uncommon.

DIERVILLA, Tourn. Bush-honeysuckle.

234. *D. trifida*, Moench.
Rocky places. Rare.

RUBIACEÆ. (MADDER FAMILY.)

HOUSTONIA, L.

235. *H. cœrulea*, L. Bluets.
South of Lake Kegonsa. Reported from Madison by Hale in 1859, in University of Wisconsin Herbarium.

CEPHALANTHUS, L. Button-bush.

236. **C. occidentalis*, L.
Low wet woods and thickets. Local.

MITCHELLA, L. Partridge-berry.

237. **M. repens*, L.
One mile east of Lake Monona. Rare.

GALIUM, L. Bedstraw. Cleavers.

238. **G. Aparine*, L. Cleavers. Goose-grass.
Common.

239. **G. circœzans*, Michx. Wild liquorice.
Occasional in rich woods.

240. *G. trifidum*, L., var. *latifolium*, Torr. Small bedstraw.
In rich woods. Not rare.

241. **G. triflorum*, Michx. Sweet-scented bedstraw.
With *G. trifidum*. Common.

VALERIANACEÆ. (VALERIAN FAMILY.)

VALERIANA. Tourn. Valerian.

242. *V. edulis*, Nutt.
In moist meadow lands bordering lakes and water-courses.

COMPOSITÆ. (COMPOSITE FAMILY.)

VERNONIA, Schreb. Iron-weed.

243. *V. fasciculata*, Michx.
Low places in pastures and along streams. Not common.

EUPATORIUM, Tourn. Thoroughwort.

244. **E. purpureum*, L. Joe-pye weed. Trumpet weed.
Common throughout the region.

245. ***E. perfoliatum*, L. Thoroughwort. Boneset.
Dry soil in open places. Not abundant.

246. *E. ageratoides*, L. White snake-root.
Very common in open woods and copses.

KUHNIA, L.

247. *K. eupatorioides*, L.
Dry hills about Madison. Rather local.

LIATRIS, Schreb. Button snakeroot. Blazing-star.

248. *L. cylindracea*, Michx.
Rocky points west of Madison. Local.

249. *L. scariosa*, Willd.
Along railroads and on dry wild land; everywhere.

SOLIDAGO, L. Golden-rod.

250. *S. latifolia*, L.
Woods and copses. Very common.

251. *S. stricta*, Ait.
Not uncommon in low moist places.

252. *S. speciosa*, Nutt.
Growing in rich copses. Rather common.

253. *S. ulmifolia*, Muhl.
Borders of open woods. Very common in some localities.

254. *S. Missouriensis*, Nutt.
Not rare in all dry open land.

255. *S. serotina*, Ait.
Common throughout the region; passing by all grades of variation into the next.

256. *S. serotina*, Ait. var. *gigantea*, Gray.
With the species. No less common.

257. *S. Canadensis*, L.
Very common everywhere.

258. *S. nemoralis*, Ait.
On rocky and gravelly soil. Common.

259. *S. rigida*, L.
Growing on dry hills. Rather local.

260. *S. Riddellii*, Frank.
Low moist places. Not common.

261. *S. lanceolata*, L.
Moist grassy copses, and along fences in similar places. Not abundant.

BELLIS, Tourn. Daisy.

262. *B. integrifolia*, Michx. Western daisy.
(The right of this species to a place in the present list is doubtful. In 1890 it was reported as occurring here, but no specimens of it have been preserved and it has not been observed since.)

ASTER, L. Starwort. Aster.

263. *A. Novæ-Angliæ*, L.
Low wet pastures. Very common.

264 *A. sericeus*, Vent.
Growing on dry rocky points about Madison. Local.

265. *A. azureus*, Linde.
On sandy or gravelly soil. Not common.

266. *A. sagittifolius*, Willd.
Dry grounds throughout the region. Common.

267. *A. turbinellus*, Lindl.
Common on dry soil.

268. *A. lævis*, L.
Dry gravelly or sandy places. Not common.

269. *A. multiflorus*, Ait.
Not uncommon in dry soil along fences and in copses.

270. *A. diffusus*, Ait., var. *hirsuticaulis*, Gray.
Everywhere common in fields and thickets.

271. *A. Tradescanti*, L.
Low grounds. Not rare.

272. *A. paniculatus*, Lam.
Common in low lands.

273. *A. longifolius*, Lam. (of Gray's Man., 6th ed.)
Growing in rich low lands. Rather common.

274. *A. Novi-Belgii*, L.
Occurring occasionally throughout the region.

275. *A. puniceus*, L.
Low thickets and swamps. Very abundant.

276. *A. umbellatus*, Mill.
Low moist thickets. Not rare.

277. *A. linariifolius*, L.
Sandy hillsides west of Madison. Rare.

278. *A. ptarmicoides*, Torr. & Gray.
Dry hills about Madison. Rather local.

ERIGERON, L. Fleabane.

279. **E. Canadensis*, L. Horse-weed. Butter-weed. (*E. Canadense*, L.)
Very common in open woodlands and cultivated fields.

280. **E. annuus*, Pers. Daisy fleabane. Sweet scabious.
A very common weed in meadows. Popularly known in many places as "white top."

281. **E. strigosus*, Muhl. Daisy fleabane.
Common everywhere.

282. *E. bellidifolius*, Muhl. Robin's plantain.
Dry soil in open woods and brush land.

283. **E. Philadelphicus*, common fleabane.
Rather common in moist places.

ANTENNARIA, Gærtn. Everlasting.

284. **A. plantaginifolia*, Hook. Plantain-leaved everlasting.
On dry soil everywhere. Common.

ANAPHALIS, DC. Everlasting.

285. **A. margaritacea*, Benth. & Hook. Pearly everlasting. (*Gnaphalium margaritaceum*, L.)
Dry sandy soil in a few places about Madison. Local.

INULA, L. Elecampane.

286. **I. HELENIUM, L.
Roadside about four miles west of Madison on Mineral Point road.

POLYMNIA, L. Leaf-cup.

287. *P. Canadensis*, L.
Growing in low wet woods about Lakes Wingra and Monona. Not common.

SILPHIUM, L. Rosin-weed.

288. **S. laciniatum*, L. Rosin-weed. Compass-plant.
Growing along railroads and on little spots of wild land in fields. Not rare.

289. **S. terebinthinaceum*, L. Prairie dock.
With *S. laciniatum.*

290. *S. integrifolium*, Michx.
Throughout the region in dry open places. Common.

291. *S. perfoliatum*, L. Cup-plant.
Growing in moist places. Not common.

AMBROSIA, Tourn. Ragweed.

292. **A. trifida*, L. Great ragweed.
Low places, especially banks of streams. Common.

293. **A. artemisiæfolia*, L. Roman wormwood. Hog-weed. Bitter-weed.
This is perhaps our commonest weed, growing in all soils under all sorts of conditions.

XANTHIUM, Tourn. Cocklebur. Clotbur.

294. *X. Canadense*, Mill. (*X. strumarium*, L.)
Cultivated lands everywhere. In many places a very troublesome weed. Not especially abundant in this region.

HELIOPSIS, Pers.

295. *H. lævis*, Pers.
Rather common everywhere.

RUDBECKIA, L. Cone-flower.

296. *R. laciniata*, L.
Low thickets and borders of woods. Not common.

297. *R. hirta*, L.
Growing on dry soil everywhere.

LEPACHYS, Raf.

298. *L. pinnata*, Torr. & Gray.

Growing in dry soil, borders of woods and thickets. Common.

HELIANTHUS, L. Sunflower.

299. **H. annuus*, L.

Persisting occasionally after cultivation. Very common in cultivation.

300. *H. rigidus*, Desf.

Common in dry rocky woods and thickets.

301. *H. occidentalis*, Riddell.

Dry open lands throughout the region.

302. *H. grosse-serratus*, Martens.

Not uncommon on dry rich soil.

303. *H. strumosus*, L.

Low copses. Not rare.

304. *H. decapetalus*, L.

Not rare in borders of thickets and in low land along streams.

COREOPSIS, L. Tickseed.

305. *C. palmata*, Nutt.

In dry soil throughout the region. Rather common.

306. *C. trichosperma*, Michx. Tickseed sunflower.

Not rare in the marsh land south of Madison.

BIDENS, L. Bur-marigold.

307. *B. frondosa*, L. Common beggar-ticks. Stick-tight.

Common.

308. *B. connata*, Muhl. Swamp beggar-ticks.

Common in low lands.

309. *B. chrysanthemoides*, Michx. Large bur-marigold.

Abundant in swampy grounds about Madison.

ANTHEMIS, L. Chamomile.

310. *A. COTULA, DC. May-weed.

Very common in waste places and along roadsides.

ACHILLEA, L. Yarrow.

311. **A. Millefolium*, L. Common yarrow or milfoil.

Of common occurrence throughout the region.

CHRYSANTHEMUM, Tourn. Ox-eye daisy.

312. C. LEUCANTHEMUM, L. Ox-eye or white daisy. White-weed.
Very abundant in a pasture four miles west of Madison. Occurring in many other places in small numbers. Not common.

TANACETUM, L. Tansy.

313.**T. VULGARE, L. Common tansy.
Persisting in many places after cultivation.

ARTEMISIA, L. Wormwood.

314. *A. candata*, Michx.
Common in dry soil throughout the region.

315. **A. Ludoviciana*, Nutt. Western mugwort.
Growing on dry sandy points about Madison. Rather local.

316. *A. biennis*, Willd.
In gravelly places. Not common.

SENECIO, Tourn. Groundsel.

317. **S. aureus*, L. Golden ragwort. Squaw-weed.
Common everywhere.

CACALIA, L. Indian plantain.

318. *C. atriplicifolia*, L. Pale Indian plantain.
This species was observed growing as the crossing of the C. M. & St. P. R. R. and the C. & N. W. R. R. east of Elmside, Madison. Rare.

ERECHTITES, Raf. Fireweed.

319. *E. hieracifolia*, Raf. Fireweed.
Growing in the marshes about the lakes and on ground newly cleared and burned over. Not rare.

ARCTICUM, L. Burdock.

320.**A. LAPPA, L.
A common weed about dwellings, old buildings and in waste places.

CNICUS, Tourn. Common or plumed thistle.

321. C. LANCEOLATUS, Hoffm. Common thistle.
Very common throughout the region.

322. *C. altissimus*, Willd.
Rocky open woods. Common.

323. *C. altissimus*, Willd., var. *discolor*, Gray.
Growing with the species.

324. *C. muticus*, Pursh. Swamp thistle.
Low wet meadows and pastures. Common.

325. *C. pumilus*, Torr. Pasture thistle.
Growing in dry pastures. Along C. M. & St. P. R. R. west of Madison. Not common.

326. C. ARVENSIS, Hoffm. Canada thistle.
Roadsides in Madison, 5th ward, Mills street at crossing of C. M. & St. P. R. R., north of C. M. & St. P. depot. Pasture west of old Camp Randall.

CHICORIUM, Tourn. Succory or chicory.

327. *C. INTYBUS, L.
In Madison, roadsides along University avenue and other streets. Fairground. Spreading rapidly as a weed along roads.

TRAGOPOGON, L. Goat's-beard.

328. T. PORRIFOLIUS, L. Salsify. Oyster-plant.
Escaped. Growing along I. C. R. R. west of Madison.

329. T. PRATENSIS, L. Goat's-beard.
Observed in two or three places along railroads. Not common.

HIERACIUM, Tourn. Hawkweed.

330. *H. Canadense*, Michx.
Dry woods throughout the region. Common.

331. *H. venosum*, L. Rattlesnake-weed.
Common everywhere.

PRENANTHES, Vaill. Rattlesnake-root.

332. *P. racemosa*, Michx.
Growing in rich open woods. Not rare.

333. **P. alba*, L. White lettuce. Rattlesnake-root.
Borders of woods and thickets. Common.

TROXIMON, Nutt.

334. *T. cuspidatum*, Pursh.
A few specimens collected at old stone quarry north of C. M. & St. P. R. R. west of Madison. Rare.

TARAXACUM, Haller. Dandelion.

335.**T. OFFICINALE, Weber. Common dandelion.
Everywhere as a persistent weed.

LACTUCA, Tourn. Lettuce.

336. *L. SCARIOLA, L. Prickly lettuce.
Common in waste places as a weed. Spreading very rapidly along railroads.

337. *L. Canadensis*, L. Wild lettuce.
Common throughout the region.

338. *L. Floridana*, Gaertn.
Growing in rich soil and newly cleared land. Not rare.

SONCHUS, L. Sow-thistle.

339. S. OLERACEUS, L. Common sow-thistle.
Very common along railroads and in waste grounds.

340. S. ASPER, Vill. Spiny leaved sow-thistle.
Growing with the preceding. Less common.

341. S. ARVENSIS, L. Field sow-thistle.
A single specimen of this species collected in 1890 on the University of Wisconsin farm. Not observed since.

LOBELIACEÆ. (LOBELIA FAMILY.)

LOBELIA, L.

342. **L. syphilitica*, L. Great lobelia.
Common in low moist places.

343.***L. inflata*, L. Indian tobacco.
In dry soil. Rather rare.

344. *L. spicata*, Lam.
Growing in dry grassy places. Not common.

345. *L. Kalmii*, L.
Growing in the marsh land about the lakes. Common.

CAMPANULACEÆ. (CAMPANULA FAMILY.)

SPECULARIA, Heister. Venus's looking-glass.

346. *S. perfoliatum*, A. DC.
Sterile, open grounds. Not common.

CAMPANULA, Tourn. Bellflower.

347. *C. rotundifolia*, L. Harebell.
Growing in sandy soil. Not common.

348. *C. aparinoides*, Pursh. Marsh bellflower.
Common in the marsh land about the lakes.

349. *C. Americana*, L. Tall bellflower.
Low rich woods. Not common.

ERICACEÆ. (HEATH FAMILY.)

VACCINIUM, L. Blueberry. Bilberry. Cranberry.

350. *V. Pennsylvanicum*, Lam. Dwarf blueberry.
A few specimens collected at Hook Lake.

351. *V. corymbosum*, L.
Growing with the preceding. Much more abundant.

CASSANDRA, Don. Leather-leaf.

352. *C. calyculata*, Don.
Growing at Hook Lake. Peat bog in Section 36, town of Madison.

CHIMAPHILA, Pursh. Pipsissewa.

353.***C. umbellata*, Nutt. Prince's pine. Pipsissewa.
In woods west of Madison. Local.

PYROLA, Tourn. Wintergreen. Shin-leaf.

354. *P. secunda*, L.
Growing on wooded hillside near I. C. R. R. west of Madison. Rare.

355. **P. elliptica*, Nutt. Shin-leaf.
Throughout the region in rich woods.

MONOTROPA, L. Indian pipe. Pine-sap.

356. *M. uniflora*, L. Indian-pipe. Corpse-plant.
Rich woods. Widely distributed. Not common.

PRIMULACEÆ. (PRIMROSE FAMILY.)

DODECATHEON, L. American cowslip.

357. *D. Meadia*, L. Shooting-star.
Common throughout region.

TRIENTALIS, L. Chickweed-wintergreen.

358. *T. Americana*, Pursh. Star-flower.
A few plants found in tamarack swamp near Windsor. Not observed elsewhere.

STEIRONEMA, Raf.

359. *S. ciliatum*, Raf.
Rich woods and thickets. Very common.

360. *S. lanceolatum*, Gray.
In woods west of old Camp Randall, Madison. Rare.

361. *S. longifolium*, Gray.
Common in wet meadows.

LYSIMACHIA, Tourn. Loosestrife.

362. *L. quadrifolia*, L.
In dry rocky land. Not common.

363. *L. thrysiflora*, L. Tufted loosestrife.
Common about the margins of the lakes.

OLEACEÆ. (OLIVE FAMILY.)

FRAXINUS, Tourn. Ash.

364. **F. Americana*, L. White ash.
A common tree in all the woods of the region.

365. *F. sambucifolia*, Lam. Black ash.
In low wet woods. Rather local.

APOCYNACEÆ. (DOGBANE FAMILY.)

APOCYNUM, Tourn. Dogbane. Indian hemp.

366. **A. androsæmifolium*, L. Spreading dogbane.
Borders of thickets and open woods. Common.

367. ***A. cannabinum*, L. Indian hemp.
In moist places. Less common than the preceding.

ASCLEPIADACEÆ. (MILKWEED FAMILY.)

ASCLEPIAS, L. Milkweed. Silkweed.

368.**A. *tuberosa*, L. Buutterfly-weed. Pleurisy-root.
Dry open woods. Common.

369. *A. purpurascens*, L. Purple milkweed.
Abundant in low meadows and pastures.

370. **A. incarnata*, L., var. *pulchra*, Pers. Swamp milkweed.
Not uncommon in low land.

371. **A. Cornuti*, Decaisne. Common milkweed or silkweed.
Common everywhere.

372. *A. obtusifolia*, Michx.
Along C. M. & St. P. R. R. west of Madison. Not common.

373. *A. phytolaccoides*, Pursh. Poke milkweed.
Occurring occasionally along railroads.

374. *A. ovalifolia*, Decaisne.
Dry places west of Madison. Local.

375. *A. verticillata*, L.
A few specimens collected along C. & N. W. R. R. south of Madison. Rare.

ACERATES, Ell. Green milkweed.

376. *A. longifolia*, Ell.
Sandy knoll northeast of Mendota. Along railroad west of Madison. Local.

377. *A. viridiflora*, Ell.
In sandy places. Not common.

378. *A. lanuginosa*, Decaisne.
Lawn near Washburn Observatory, University of Wisconsin. Dry hill west of Madison. Rare.

GENTIANACEÆ. (GENTIAN FAMILY.)

GENTIANA, Tourn. Gentian.

379. *G. crinita*, Froel.
Not rare in low wet meadows.

380. *G. serrata*, Gunner.

There is some doubt as to the affinities of the plants referred to this species. Specimens examined exhibited all grades of variation in the shape of leaf from *linear* to *lanceolate.* All, however, had petals with "fringe shorter or almost obsolete at the summit," and all had the ovary *lanceolate.* Specimens agreed with herbarium specimens of *G. serrata* (*detonsa*), which are supposed to be authentic.

In marsh on road to Fish Hatchery from Madison.

381. *G. quinqueflora*, Lam.

Dry hillsides. Not common.

382. **G. puberula*, Michx.

On sandy hills west of Madison. Local.

383. **G. Andrewsii*, Griseb. Closed gentian.

Common in low wild meadows.

384. *G. alba*, Muhl.

Low sandy soil. Rare.

MENYANTHES, Tourn. Buckbean.

385. **M. trifoliata*, L.

Occurring occasionally in marsh land about the lakes. Local.

POLEMONIACEÆ. (POLEMONIUM FAMILY.)

PHLOX, L.

386. P. PANICULATA, L.

Madison. Escaped from cultivation.

387. *P. pilosa*, L.

Not rare in dry rich land.

388. *P. divaricata*, L.

Common.

POLEMONIUM, Tourn. Greek valerian.

389. *P. reptans*, L.

Merrill Springs. Woods northeast of Mendota Rare.

HYDROPHYLLACEÆ. (WATERLEAF FAMILY.)

HYDROPHYLLUM, Tourn. Waterleaf.

390. *H. Virginicum*, L.
Rich woods. Common.

391. *H. appendiculatum*, Michx.
Near slaughter house northeast of Madison. At Winnequah.

ELLISIA, L.

392. *E. Nyctelea*, L.
At mill on Yahara river. Along C. M. & St. P. R. R. west of Madison. Rare.

BORRAGINACEÆ. (BORAGE FAMILY.)

CYNOGLOSSUM, Tourn. Hound's-tongue.

393. *C. OFFICINALE, L. Common hound's-tongue.
Along the I. C. R. R. in the city of Madison. Not common.

ECHINOSPERMUM, Lehm. Stickseed.

394. *E. Virginicum*, Lehm. Beggar's lice.
Common in rich woods.

395. E. LAPPULA, Lehm.
Throughout the region. Not common.

MERTENSIA, Roth. Lungwort.

396. *M. VIRGINICA, DC. Virginian cowslip. Lungwort. Blue bells.
In garden in east Madison. Not observed in the wild state, though not uncommon along the Rock and Pecatonica rivers somewhat south.

LITHOSPERMUM, Tourn. Gromwell. Puccoon.

397. *L. hirtum*, Lehm.
Rather common in dry places.

398. *L. angustifolium*, Michx.
On high sandy points about Madison. Not common.

SYMPHYTUM, Tourn. Comfrey.

399. *S. OFFICINALE, L. Common comfrey.
Persisting about the U. W. farm where it was cultivated as a forage plant.

CONVOLVULACEÆ. (CONVOLVULUS FAMILY.)

IPOMEA, L. Morning glory.

400. I. PURPUREA, Linn. Common morning glory.
Escaping occasionally from cultivation.

CONVOLVULUS, Tourn. Bindweed.

401. *C. spithameus*, L.
Sandy hills west of Madison. Local.

402. *C. sepium*, L. Hedge bindweed.
Too common along railroad embankments and in cultivated fields.

403. *C. sepium*, L., var. *Americanus*, Sims.
With the species. No less common.

404. *C. sepium*, L., var. *repens*, Gray.
With the two preceding. Not rare.

405. C. ARVENSIS, L. Bindweed.
Agricultural Experimental Farm, near Hiram Smith Hall. Along railroad near Angleworm station, Madison. Rare.

CUSCUTA, Tourn. Dodder.

406. *C. chlorocarpa*, Engelm.
In moist places. Less common than *C. Gronovii.*

407. *C. Gronovii*, Willd.
Common in wet land.

408. *C. glomerata*, Choisy.
On Compositæ along streams. Not rare.

SOLANACEÆ. (NIGHTSHADE FAMILY.)

SOLANUM, Tourn. Nightshade.

409.**S. DULCAMARA, L. Bittersweet.
Woods west of Fair grounds. Local.

410. **S. nigrum*, L.
Common in fields.

PHYSALIS, L. Ground cherry.

411. *P. Philadelphica*, Lam.
Along railroad embankments. Not common.

412. **P. pubescens*, L.
Common in sandy soil.

LYCIUM, L. Matrimony-vine.

413. **L. vulgare*, Dunal.
A few specimens found growing along I. C. R. R. west of Madison.

SCROPHULARIACEÆ. (FIGWORT FAMILY.)

VERBASCUM, L. Mullein.

414. *V. THAPSUS, L. Common mullein.
Common in pastures and fields.

LINARIA, Tourn. Toad-flax.

415. *L. VULGARIS, Mill. Ramsted. Butter and eggs.
Common about dwellings as an escape from cultivation.

SCROPHULARIA, Tourn. Figwort.

416. *S. nodosa*, L., var. *Marylandica*, Gray. (*S. nodosa*, L.)
Common throughout the region.

CHELONE, Tourn. Turtle-head. Snake-head.

417. **C. glabra*, L.
Low wet meadow land. Not rare.

MIMULUS, Monkey-flower.

418. *M. ringens*, L.
Growing in the marsh land about the lakes. Common.

419. *M. Jamesii*, Torr.
Near springs south of Lake Wingra. Merrill Springs. Rare.

ILYSANTHES, Raf.

420. *I. riparia*, Raf. False pimpernel.
In wet places. Local.

VERONICA, L. Speedwell.

421.** *V. Virginica*, L. Culver's-root. Culver's physic.
Rich woods. Everywhere.

422. **V. Americana*, Schweinitz. American brooklime.
Brooks and ditches. Not rare.

423. *V. serpyllifolia*, L. Thyme-leaved speedwell.
Wet pastures. Not rare.

424. *V. peregrina*, L. Neckweed. Purslane speedwell.
Very abundant in low cultivated land.

425. V. ARVENSIS, L. Corn speedwell.
Bank of Yahara river near Stoughton.

GERARDIA, L.

426. *G. grandiflora*, Benth.
Growing on dry wooded hills. Not rare.

427. *G. purpurea*, L. Purple gerardia.
Very abundant in low meadows and pastures.

428. *G. tenuifolia*, Vahl. Slender gerardia.
A few specimens found in wet pasture south of Madison. Rare.

CASTILLEIA, Mutis. Painted-cup.

429. *C. coccinea*, Spreng. Scarlet painted-cup.
On dry soil in open woods. Not common.

430. *C. sessiliflora*, Pursh.
A half dozen specimens of this species were collected on a rocky hill west of Madison. Not observed elsewhere.

PEDICULARIS, Tourn. Lousewort. Wood betony.

431. *P. Canadensis*, L. Common lousewort. Wood betony.
On dry uplands. Not uncommon.

432. *P. lanceolata*, Michx.
Common in low grounds.

LENTIBULARIACEÆ. (BLADDERWORT FAMILY.)

UTRICULARIA, L. Bladderwort.

433. *U. vulgaris*, L. Greater bladderwort.
Common about the muddy margins of the lakes.

BIGNONIACEÆ. (BIGNONIA FAMILY.)

TECOMA, Juss. Trumpet-flower.

434. *T. RADICANS, Juss.
Cultivated here, growing wild in central Illinois.

VERBENIACEÆ. (VERVAIN FAMILY.)

VERBENA, Tourn. Vervain.

435. *V. urticæfolia*, L. White vervain.
In open woods and pastures. Common.

436. *V. hastata*, Blue vervain.
With *V. urticæfolia* and as abundant.

437. *V. stricta*, Vent. Hoary vervain.
Along railroads and on dry hills about Madison. Not common.

438. *V. bracteosa*, Michx.
Dry, sandy and gravelly soil throughout the region. Rather common.

PHRYMA, L. Lopseed.

439. *P. Leptostachya*, L.
Rich woods. Very common.

LABIATÆ. (MINT FAMILY.)

TEUCRIUM, Tourn. Germander.

440. **T. Canadense*, L. American germander. Wood sage.
Occurring occasionally about the lakes.

441. *T. occidentale*, Gray.
Lake shore near University drive, Experiment Farm. Rather common in low ground. Dr. Stanley Coulter kindly verified this determination.

MENTHA, Tourn. Mint.

442. **M. VIRIDIS, L. Spearmint.
Picnic Point, Lake Mendota.

443. *M. Canadensis*, L. Wild mint.
Common in low pastures, along watercourses and about the margins of the lakes.

LYCOPUS, Tourn. Water horehound.

444. *L. sinuatus*, Ell.
Common.

PYCNANTHEMUM, Michx. Mountain mint. Basil.

445. **P. lanceolatum*, Pursh.
Common in wet meadow land.

HEDEOMA, Pers. Mock pennyroyal.

446.***H. pulegioides*, Pers. American pennyroyal.
In dry soil. Throughout this region but not abundant.

MONARDA, L. Horse-mint.

447. **M. fistulosa*, L. Wild bergamont.
Abundant everywhere.

448. **M. punctata*, L. Horse-mint.
Three or four specimens of this species were collected near the Fuller and Johnson Plow Works, Madison. Not observed elsewhere in this region.

BLEPHILIA, Raf.

449. *B. ciliata*, Raf.
Growing in wild meadow land northeast of Mendota and south of Lake Wingra. Local.

LOPHANTHUS, Benth. Giant hyssop.

450. *L. nepetoides*, Benth.
Growing beside the C. M. & St. P. R. R. east of Elmside. Rare.

NEPETA, L. Cat-mint.

451. *N. CATARIA, L. Catnip.
Common in waste grounds.

452. *N. GLECHOMA, Benth. Ground ivy. Gill-over-the-ground.
Along fences and sidewalks. Rather common.

SCUTELLARIA, L. Skullcap.

453.***S. lateriflora*, L. Mad-dog skullcap.
Wet shady places. Common.

454. *S. parvula*, Michx.
In dry soil. Local.

455. *S. *galericulata*, L.
In wet land about the lakes. Abundant.

BRUNELLA, Tourn. Self-heal.
456. *B. *vulgaris*, L. Common self-heal or heal-all.
Very common.

LEONURUS, L. Motherwort.
457. *L. CARDIACA, L. Common motherwort.
In rich soil. Common.

STACHYS, Tourn. Hedge-nettle.
458. S. *aspera*, Michx.
Flowers finely pubescent! Growing in low places.
Not rare.

PLANTAGINACEÆ. (PLANTAIN FAMILY.)

PLANTAGO, Tourn. Plantain. Ribwort.
459. *P. *major*, L. Common plantain.
Common as a persistent weed in lawns, waste grounds and by roadsides.
460. *P. LANCEOLATA, L. Rib grass. Ripplegrass.
Growing on campus near Science Hall, on private lawn near Science Hall and along I. C. R. R. west of Madison.

APETALÆ.

NYCTAGINACEÆ. (FOUR-O'CLOCK FAMILY.)

OXYBAPBUS, Vahl.
461. O. *nyctagineus*, Sweet.
Along C. M. & St. P. R. R. in Madison and west of the city.

AMARANTACEÆ. (AMARANTH FAMILY.)

AMARANTUS, Tourn. Amaranth.
462. A. RETROFLEXUS, L. Pigweed.
A rank weed in cultivated fields. Common.

463. *A. albus*, L. Tumble weed.
Abundant on newly cleared land.

464. *A blitoides*, Watson.
Growing in waste ground. Not common.

ACNIDA, Mitch. Water-hemp.

465. *A tuberculata*, Moq.
Common about the margins of the lakes.

CHENOPODIACEÆ. (GOOSEFOOT FAMILY.)

CHENOPODIUM, Tourn. Goosefoot. Pigweed.

466. *C. ALBUM, L. Lamb's-quarters. Pigweed.
A common weed everywhere.

467. C. MURALE, L.
Collected at Madison. Not common.

468. *C. hybridum*, L. Maple-leaved goosefoot.
In rich soil, widely distributed. Not abundant.

469. *C. capitatum*, Watson. Strawberry blite.
Dry rich soil. Rare.

470. **C. AMBROSIOIDES, L., var. ANTHELMINTICUM, Gray Wormseed.
In the I. C. R. R. yards. Rare.

ATRIPLEX, Tourn. Orache.

471. *A. patulum*, L., var. *hastatum*, Gray.
In all parts of Madison. Local.

SALSOLA, L. Saltwort.

472. S. KALI, L. Common saltwort.
Railroad track near Prof. King's house near Agricultural Experiment Farm. Found east of Madison along railroad track near Yahara river. Along N. W. R. R. south of Lake Monona. Becoming more abundant.

POLYGONACEÆ. (BUCKWHEAT FAMILY.)

RUMEX, L. Dock. Sorrel.

473. *R. Brittannica*, L. Great water-dock.
Growing in shallow water at margins of lakes and streams.

474. *R. altissimus*, Wood. Pale dock.
In marshes about the lakes. Common.

475. *R. verticillatus*, L. Swamp dock.
With *R. altissimus*. Not common.

476. **R. CRISPUS, L. Curled dock.
A weed in cultivated land.

477. **R. OBTUSIFOLIUS, L. Bitter dock.
With R. CRISPUS. More abundant.

478. R. ACETOSELLA, L. Field or sheep sorrel.
Abundant along railroads and on sandy soil.

POLYGONUM, Tourn. Knotweed.

479. **P. aviculare*, L.
Common in yards and along roadsides.

480. *P. erectum*, L.
With *P. aviculare*. Less abundant.

481. *P. Pennsylvanicum*, L.
In low wet places. Common.

482. **P. amphibium*, L.
In shallow water. Local.

483. *P. Muhlenbergii*, Watson.
Growing in muddy places. Not common.

484. *P. Hartwrightii*, Gray.
In muddy places. Rare.

485. P. ORIENTALE, L. Prince's feather.
Occasionally escaped from cultivation.

486. *P. PERSICARIA, L. Lady's thumb.
Common in waste grounds and along roadsides.

487. **P. hydropiperoides*, Michx. Mild water-pepper.
Low wet pastures and cultivated land. Common.

488. **P. Hydropiper*, L. Common smartweed or water-pepper.
Very abundant in cultivated fields.

489. *P. Virginianum*, L.
Rich woods east of Lake Mendota. Local.

490. *P. sagittatum*, L. Arrow-leaved tear-thumb.
In marsh east of Lake Monona.

491. *P. dumetorum*, L., var. *scandens*, Gray. Climbing false buckwheat.
Along railroads and on newly cleared land.

FAGOPYRUM, Tourn. Buckwheat.

492. F. ESCULENTUM, Moench. Buckwheat.
Along railroads and in fields after cultivation.

ARISTOLOCHIACEÆ. (BIRTHWORT FAMILY.)

ASARUM, Tourn. Asarabacca. Wild ginger.

493. **A. Canadense*, L.
In low woods northeast of Lake Wabesa. Rare.

SANTALACEÆ. (SANDALWOOD FAMILY.)

COMANDRA, Nutt. Bastard toad-flax.

494. *C. umbellata*, Nutt.
Dry ground. Not common.

EUPHORBIACEÆ. (SPURGE FAMILY.)

EUPHORBIA, L. Spurge.

495. *E. serpyllifolia*, Pers.
Along railroads. Not common.

496. *E. glyptosperma*, Engelm.
Thin soil. Common.

497. **E. maculata*, *L.*
Along railroads and on dry hills. Everywhere very abundant.

498. **E. humistrata*, Engelm.
With *E. maculata*. Common.

499. **E. Preslii*, Guss.
Along railroads. Not so common as *E. maculata* or *E. humistrata*.

500. **E. corollata, L.*
Dry ground. Everywhere,

501. *E. CYPARISSIAS, L.
Occurring occasionally as an escape from cultivation.

502. *E. PEPLUS, L.
Spontaneous in many lawns and gardens in Madison. Local.

ACALYPHA, L. Three-seeded mercury.

503. *A. Caroliniana*, Ell.
Rich woods. Common.

URTICACEÆ. (NETTLE FAMILY.)

ULMUS, L. Elm.

504.***U. fulva*, Michx. Slippery or red elm.
Occurring occasionally throughout the region.

505. **U. Americana*, L. American or white elm.
Common, especially in low woods.

CELTIS, Tourn. Nettle-tree. Hackberry.

506. *C. occidentalis*, L. Sugarberry. Hackberry.
Occasional in the older forest tracts.

CANNABIS. Tourn. Hemp.

507.**C. SATIVA, L. Hemp.
Growing along roads and about dwellings. Not rare.

HUMULUS, L. Hop.

508.**H. *Lupulus*, L. Common hop.
Growing wild in many places.

URTICA, Tourn. Nettle.

509. *U. gracilis*, Ait.
In low rich soil. Common.

PILEA, Lindl. Richweed. Clearweed.

510. *P. pumila*, Gray.
In rich woods. Not rare.

BOEHMERIA, Jacq. False nettle.

511. *B. cylindrica*, Willd.

Very common in wet places.

PARIETARIA, Tourn. Pellitory.

512. *P. Pennsylvanica*, Muhl.

Growing on leaf mould in woods. Local.

PLATANACEÆ. (PLANE-TREE FAMILY.)

PLATANUS, L. Sycamore. Buttonwood.

513. *P. occidentalis*, L.

A single small tree on west shore of Lake Kegonsa.

JUGLANDACEÆ. (WALNUT FAMILY.)

JUGLANS, L. Walnut.

514. ***J. cinerea*, L. Butternut. White walnut.

In rich soil in open woods.

515. **J. nigra*, L. Black walnut.

With *J. cinerea*. Less common.

CARYA, Nutt. Hickory.

516. *C. alba*, Nutt. Shell-bark or shag-bark hickory.

Open woodland throughout the region.

517. *C. amara*, Nutt. Bitternut or swamp hickory.

Low lands about lakes. Not uncommon.

CUPULIFERÆ. (OAK FAMILY.)

BETULA, Tourn. Birch.

518. **B. papyrifera*, Marshall. Paper or canoe birch. (*B. papyracea*, Ait.)

North of University Hall, Madison. Cultivated. A small tree growing wild in woods south of cemetery. Growing wild at Hook Lake.

519. **B. pumila*, L. Low birch.

Marshes about the lakes. Local.

ALNUS, Tourn. Alder.

520. *A. incana*, Willd. Speckled or hoary alder.
In low lands along watercourses. Not abundant.

CORYLUS, Tourn. Hazel-nut. Filbert.

521. **C. Americana*, Watt. Wild hazel-nut.
Common everywhere.

OSTRYA, Micheli. Hop-hornbeam. Iron-wood.

522. *O. Virginica*, Willd. American hop-hornbeam. Leverwood.
Of occasional occurrence throughout the region.

QUERCUS, L. Oak.

523. ***Q. alba*, L. White oak.
In all woodlands of the region. With the exception of *Q. coccinea*, this is our most abundant oak.

524. *Q. macrocarpa*, Michx. Bur oak. Over-cup or mossy-cup oak.
This species is represented in all parts of the region by small clumps or single individuals of medium sized trees.

525. *Q. bicolor*, Willd. Swamp white oak.
Low, wet woods about the lakes. Local.

526. *Q. rubra*, L. Red oak.
Forming a considerable element in the older forests of the region.

527. *Q. coccinea*, Wang. Scarlet oak.
Forming the chief element in the oak forests of the region.

SALICACEÆ. (WILLOW FAMILY.)

SALIX, Tourn. Willow. Osier.

528. *S. discolor*, Muhl. Glaucous willow.
Wet places along lakes and watercourses. Common.

529. *S. humilis*, Marsh. Prairie willow.
Along railroads and on dry wild lands.

530. *S. candida*, Willd. Sage willow. Hoary willow.
In marsh lands about lakes. Common.

531. *S. myrtilloides*, L.
With *S. candida.* Less common.

POPULUS, Tourn. Poplar. Aspen.

532. *P.* ALBA, L. White poplar. Abele.
Occasional in cultivation.

533. *P. tremuloides*, Michx. American aspen.
Common in all the woods of the region.

534. *P. grandidentata*, Michx. Large toothed aspen.
With *P. tremuloides.* Not so common.

535. *P. balsamifera*, L. Balsam-poplar. Tacamahac.
Cultivated as shade or ornamental tree.

536. P. DILATATA, Lombardy poplar.
Cultivated in many places.

MONOCOTYLEDONES.

HYDROCHARIDACEÆ. (FROG'S-BIT FAMILY.)

ELODEA, Michx. Water-weed.

537. *E. Canadensis*, Michx. (*Anacharis Canadensis*, Planchon.)
Very abundant in most spring waters of the region. Becoming a troublesome obstruction in many streams.

VALLISNERIA, L. Tape grass. Eel grass.

538. *V. spiralis*, L.
Common in the shallow parts of the lakes.

ORCHIDACEÆ. (ORCHIS FAMILY.)

APLECTRUM, Nutt. Putty-root. Adam-and-Eve.

539. *A. hiemale*, Nutt.
Rich woodlands east of Lake Mendota. Local.

CORALLORHIZA, Haller. Coral-root.

540. **C. odontorrhiza*, Nutt.

Rare. A few specimens found in woods near quarries west of Madison.

541. **C. multiflora*, Nutt.

Dry woodlands. Widely distributed but not abundant.

SPIRANTHES, Richard. Ladies' tresses.

542. *S. cernua*, Richard.

Low grounds south of Madison.

GOODYERA, R. Br. Rattlesnake-plantain.

543. *G. pubescens*, R. Br.

Woods near I. C. R. R., two miles southwest of Madison. Rare.

CALOPOGON, R. Br.

544. *C. pulchellus*, R. Br.

Two specimens collected in wild meadow south of Lake Wingra. Very rare.

ORCHIS, L.

545. O. *spectabilis*, L. Showy orchis.

In rich woods throughout the region. Not abundant.

HABENARIA, Willd. Rein-orchis.

546. *H. tridentata*, Hook.

Low, wet meadows southwest of Windsor. Rare.

547. *H. bracteata*, R. Br.

Rich woods. Common.

548. *H. hyperborea*, R. Br.

At Merrill Springs, Lake Mendota. Rare.

549. *H. leucophæa*, Gray.

A few specimens collected along C., M. & St. P. R. R., near Lakeside. Summer of 1888. Two specimens found along same road west of U. W. Farm buildings, 1891. Not observed in either place since.

550. *H. lacera*, R. Br.
A few specimens collected south of Lake Wingra. Rare.

551. *H. psycodes*, Gray.
Growing in low thicket southeast of Lake Wingra. Rare.

CYPRIPEDIUM, L. Lady's slipper. Moccasin-flower.

552. *C. candidum*, Muhl. Small white lady's slipper.
Very abundant in limited areas in the wild meadow lands about the lakes. Especially south of Lakes Monona and Wingra.

553.***C. parviflorum*, Salisb. Smaller yellow lady's slipper.
Three specimens reported from marsh land south of Lake Wingra.

554.***C. pubescens*, Willd. Larger yellow lady's slipper.
In all the rich woodlands of the region.

555. *C. spectabile*. Salisb. Showy lady's slippor.
A few specimens found in tamarack swamp southwest of Windsor. Nearly extinct.

HÆMODORACEÆ. (BLOODWORT FAMILY.)

ALETRIS, L. Colic-root. Star-grass.

556. **A. farinosa*, L.
A few specimens found growing on little knoll in marsh northeast of Mendota. Rare.

IRIDACEÆ. (IRIS FAMILY.)

IRIS, Tourn. Flower-de-Luce.

557.***I. versicolor*, Larger blue flag.
Common in marshes.

SISYRINCHIUM, L. Blue-eyed grass.

558. *S. angustifolium*, Mill.
Common on dry sandy soil.

AMARYLLIDACEAE. (AMARYLLIS FAMILY.)

HYPOXIS, L. Star-grass.

559. *H. erecta.* L.
Usually with *Sisyrinchium angustifolium.* Less common.

DIOSCOREACEÆ. (YAM FAMILY.)

DISCOREA, Plumier. Yam.

560. **D. villosa*, L. Wild yam-root.
In thickets throughout the region.

LILIACEÆ. (LILY FAMILY.)

SMILAX, Tourn. Green brier. Cat-brier.

561. *S. herbacea*, L. Carrion-flower.
In woods, everywhere.

562. *S. ecirrhata*, Watson.
With *S. herbacea.* Less common.

563. *S. hispida*, Muhl.
In thickets. Not rare.

ALLIUM, L. Onion. Garlic.

564. *A. tricoccum*, Ait. Wild leek.
Rich woods. Widely distributed.

565. *A. Canadense*, Kalm. Wild garlic.
Common. Generally known here as "wild onion."

POLYGONATUM, Tourn. Solomon's seal.

566. **P. biflorum*, Ell. Smaller Solomon's seal.
Low, rich woods. Not common.

567. **P. giganteum*, Dietrich. Great Solomon's seal.
Rich woodlands, throughout the region.

ASPARAGUS, Tourn. Asparagus.

568. *A. OFFICINALIS, L. Garden asparagus.
Occasionally escaped.

SMILACINA, Desf. False Solomon's seal.

569. **S. racemosa*, Desf. False spikenard.
Common in open woods.

570. *S. stellata*, Desf.
Common along railroad tracks and other banks.

MAIANTHEMUM, Wigg.

571. *M. Canadense*, Desf.
Low, wet woods north of Lake Wabesa. In a similar place west of Lake Wingra. Local.

UVULARIA, L. Bellwort.

572. *U. grandiflora*, Smith.
In all woodlands.

ERYTHRONIUM, L. Dog's-tooth violet.

573. *E. albidum*, Nutt. White dog's-tooth violet.
Rich woods about the lakes.

LILIUM, L. Lily.

574. *L. Philadelphicum*, L. Wild orange-red lily. Wood lily.
Along railroads and in other places on wild land.

575. *L. superbum*, L. Turk's-cap lily.
Margins of wild meadows. Rather rare.

TRILLIUM, L. Wake robin. Birthroot.

576. **T. erectum*, L.
In rich woods east of Lake Mendota. Not common.

577. **T. grandiflorum*, Salisb.
With *T. erectum*. Much rarer.

PONTEDERIACEÆ. (PICKEREL-WEED FAMILY.)

PONTEDERIA, L. Pickerel-weed.

578. *P. cordata*, L.
Abundant in northwestern part of Lake Wingra. Local.

HETERANTHERA, Ruiz & Pav. Mud-plantain.

579. *H. graminea*, Vahl.
Yahara river below Lake Monona. Dr. Chas. Morong kindly determined this species.

COMMELINACEÆ. (SPIDERWORT FAMILY.)

TRADESCANTIA, L. Spiderwort.

580. *T. Virginica*, L. Common spiderwort.
Along railroads. Not uncommon.

JUNCACEÆ. (RUSH FAMILY.)

JUNCUS, Tourn. Rush. Bog-rush.

581. *J. tenuis*, Willd.
In paths, everywhere.

582. *J. bufonis*, L.
Roadsides in low places. Not common.

583. *J. nodosus*, L.
Wet meadows. Occasional.

584. *J. Canadensis*, J. Gay.
Wet meadows and marshes. Rare.

LUZULA, DC. Wood-rush.

585. *L. campestris*, DC.
Hook Lake. Rare.

TYPHACEÆ. (CAT-TAIL FAMILY.)

TYPHA, Tourn. Cat-tail flag.

586. *T. latifolia*, L. Common cat-tail.
Common in marshes, especially east of city of Madison.

SPARGANIUM, Tourn. Bur-reed.

587. *S. simplex*. Huds.?
Marshes about Lake Mendota.

ARACEÆ. (ARUM FAMILY.)

ARISÆMA, Martius. Indian turnip. Dragon arum.

588. **A. triphyllum*, Torr. Indian turnip.
Low, rich woods. Not common.

SYMPLOCARPUS, Salisb. Skunk cabbage.

589. **S. fœtidus*. Salisb.
Merrill Springs and Lake Wabesa. Local.

ACORSU, L. Sweet flag. Calamus.

590. ***A. Calamus*, L.
Growing in the shallow, muddy bogs of all the lakes.

LEMNACEÆ. (DUCKWEED FAMILY.)

SPIRODELA, Schleiden.

591.***S. polyrrhiza*, Schleid.
Abundant on all quiet waters of the region.

LEMNA, L. Duckweed. Duck's-meat.

592. *L. trisulca*, L.
Growing with *Spirodela polyrrhiza.* Common.

593. *L. minor*, L.
With *L. trisulca.* Rarer.

WOLFFIA, Horkel.

594. *W. Columbiana*, Karsten.
Very abundant on the lakes in late summer and autumn.

595. *W. Braziliensis*, Weddell.
With *W. Columbiana*, much rarer.

ALISMACEÆ. (WATER-PLANTAIN FAMILY.)

ALISMA, L. Water-plantain.

596. **A. Plantago*, L.
Common in ditches, at margins of ponds, etc.

SAGITTARIA, L. Arrow-head.

597. *S. variabilis*, Engelm.
Everywhere in shallow water.

NAIADACEÆ. (PONDWEED FAMILY.)

TRIGLOCHIN, L. Arrow-grass.

598. *T. maritima*, L.
Growing in marshy grass land about lakes. Rare.

POTAMOGETON, Tourn. Pondweed.

599. *P. natans*, L.
Common in all the waters of the region.

600. *P. fluitans*, Roth.
University bay, Lake Mendota.

601. *P. amplifolius*, Tuckerm.
Growing in Lakes Wingra and Wabesa.

602. *P. perfoliatus*, L.
Common.

603. *P. zosteræfolius*, Schum.
University bay, Lake Mendota.

604. *P. mucronatus*, Schrad.
Lagoon on Picnic Point.

605. *P. pectinatus*, L.
University bay, Lake Mendota.

606. *P. marinus*.
Lagoon on Picnic Point.

NAIAS, L. Naiad.

607. *N. flexilis*, Rostk. & Schmidt.
With *Potamogeton marinus*.

CYPERACEÆ. (SEDGE FAMILY.)

CYPERUS, Tourn. Galingale.

608. *C. diandrus*, Torr.
Common on sandy beaches.

609. *C. Schweinitzii*, Torr.
Sandy ridge east of Lake Wingra. Rare.

610. *C. filiculmis*, Vahl.
Dry, sandy soil about the lakes. Local.

611. *C. strigosus*, L.
Rather common in wet sandy places.

DULICHIUM, Pers.

612. *D. spathaceum*, Pers.
Growing in shallow water along margins of lakes. Not rare.

ELEOCHARIS, R.Br. Spike-rush.

613. *E. ovata*, R.Br.
Common about ponds.

614. *E. palustris*, R.Br.?
Shallow places in the lakes and in very wet land Common.

615. *E. compressa*, Sullivant.
Wet places. Not common.

616. *E. acicularis*, R.Br.
Muddy places. Widely distributed.

SCIRPUS, Tourn. Bulrush or club-rush.

617. *S. pungens*, Vahl.
Lake shores. Local.

618. *S. lacustris*, L. Great bulrush.
Common in all the shallow waters of the region.

619. *S. atrovirens*, Muhl.
Collected on north side of Lake Wingra. Not common.

ERIOPHORUM, L. Cotton-grass.

620. *E. cyperinum*, L.
Wet meadows and marshes. Common.

621. *E. polystachyon*, L.
Growing in all the marsh land of the region. Not uncommon.

CAREX, Ruppins. Sedge.

622. *C. lupulina*, Muhl.
Wet thickets. Not abundant.

623. *C. lupulina*, Muhl., var. *pedunculata*, Dewey.
Growing with the species.

624. *C. Tuckermani*, Dewey.
Growing at the edge of a pond east of Madison. Rare.

625. *C. retrorsa*, Schwein.
Rather common in wet places.

626. *C. hystricina*, Muhl.
In shallow water or wet places. Not rare.

627. *C. Pseudo-Cyperus*, L., var. *Americana*, Hochst.
Wet meadows and marshes. Rather common.

628. *C. filiformis*, L.
Growing in marsh south of Lake Wingra. Local.

629. *C. filiformis*, L. Var., *latifolia*, Boeckl.
In places similar to that in which the species was found. More abundant.

630. *C. riparia*, W. Curtis.
Common in very wet meadows.

631. *C. stricta*, Lam.
The commonest *Carex* in all marsh lands. This species forms a very large element of the "wild hay" of this region.

632. *C. stricta*, Lam. var., *decora*, Bailey.
Growing with the species. Less common.

633. *C. limosa*, L.
A few specimens collected in marsh south of Lake Wingra. Rare.

634. *C. longirostris*, Torr.
Growing on shady banks. Not common.

635. *C. laxiflora*, Lam.
Moist, shady places. Not abundant.

636. *C. platyphylla*. Carey.
Growing in moist, rich woods. Local.

637. *C. Pennsylvanica*, Lam.
Very common in dry open woods.

638. *C. stipata*, Muhl.
Forming large tufts in low meadows and pastures. Widely distributed.

639. *C. decomposita*, Muhl.
In marshes or low lands. Local.

640. *C. teretiuscula*, Gooden.
Growing in loose tufts in wet places. Common.

641. *C. rosea*, Schkuhr., var. *radiata*, Dewey.
In dry, open woods. Not rare.

642. *C. sparganioides*, Muhl.
Not rare in rich woods.

643. *C. cephalophora*, Muhl.
Forming tufts in dry soil. Rather common.

644. *C. echinata*, Murray, var. *microstachys*, Bœckl.
Wet meadows. Common.

645. *C. siccata*, Dewey.
Sandy fields and banks. Abundant.

646. *C. tribuloides*, Wahl., var. *cristata*, Bailey.
Forming tufts in low, wet places. Rather common.

647. *C. scoparia*, Schkuhr.
Common in wet meadows and swales.

648. *C. straminea*, Willd.
Common throughout the region.

649. *C. straminea*, Willd., var. *fœnea*, Torr.
With the species.

650. *C. straminea*, Willd., var. *brevior*, Dewey.
With the species.

GRAMINEÆ. (GRASS FAMILY.)

SPARTINA, Schreber. Cord or marsh grass.

651. *S. cynosuroides*, Willd. Fresh-water cord-grass.
Growing in wet places throughout the region. Not uncommon.

PANICUM, L. Panic-grass.

652. P. SANGUINALE, L. Common crab-or finger-grass.
Rich cultivated and waste grounds. Very common.

653. *P. capillare*, L. Old-witch grass.
Common in sandy soil.

654. *P. virgatum*, L.
Growing on dry soil along railroads and on spots of wild land in fields. Local.

655. *P. latifolium*, L.
Dry places on wild grass land and along railroads about Madison. Not uncommon.

656. *P. dichotomum*, L.
With *P. latifolium*. Much more abundant.

657. *P. laxiflorum*, Lam.
Growing on dry hills about Madison. Common.

658. *P. depauperatum*, Muhl.
Dry, rocky points west of Madison. Local.

659. P. CRUS-GALLI, L. Barnyard-grass.
Low, wet places in fields and along roadsides. Common.

SETARIA, Beauv. Bristly foxtail grass.

660. S. GLAUCA, Beauv. Fox tail. Pigeon-grass.
Very common in all cultivated fields and in old pastures and meadows.

661. S. VIRIDIS, Beauv. Green foxtail. Bottle-grass.
With S. GLAUCA. Less common.

662. S. ITALICA, Kunth. Millet. Hungarian or Bengal grass.
Cultivated as a forage crop. Persisting after cultivation.

CENCHRUS, L. Hedgehog or bur-grass.

663. *C. tribuloides*, L.
Growing along railroads and in sandy fields. Not rare.

LEERSIA, Schwartz. White grass.

664. *L. Virginica*, Willd. White grass.
Occasionally met with in open woods. Not common.

665. *L. oryzoides*, Schwartz. Rice cut-grass.
Growing in ditches, sluggish branches and shallow ponds. Common.

ZIZANIA, Gronov. Water or Indian rice.

666. *Z. aquatica*, L. Indian rice.
Abundant in Lake Wingra. Occurring in many places in the marshes about Lakes Mendota, Monona and Waubesa. Local.

ANDROPOGON, Royen. Beard-grass.

667. *A. furcatus*, Muhl.
Common in the dry portions of all wild lands, in fields and along railroads.

668. *A. scoparius*, Michx.
Growing with *A. furcatus*. Much less common.

CHRYSOPOGON, Trin.

669. *C. nutans*, Benth. Indian grass. Wood-grass.
Dry ground borders of woods and copses. Local

HIEROCHLOE, Gmelin. Holy grass.

670. *H. borealis*, Roem. & Schultes. Vanilla or Seneca grass.
Growing in low, moist grass land south of Lake Monona along C. M. & St. P. R. R.

STIPA, L. Feather-grass.

671. *S. spartea*, Trin.
Along the C. M. & St. P. R. R. near the University of Wisconsin farm and farther west. Rare.

ORYZOPSIS, Michx. Mountain rice.

672. *O. melanocarpa*, Muhl.
Growing in woods north of University Hall. Not observed elsewhere.

MUHLENBERGIA, Schreber. Drop-seed grass.

673. *M. glomerata*, Trin.
Rather common in the marshes about the lakes.

674. *M. Mexicana*, Trin.
With *M. glomerata*. More inclined to be local in its distribution.

675. *M. sylvatica*, Torr. & Gray.
Moist woods and copses. Not rare.

676. *M. Wildenovii*, Trin.
Rocky woods. Rare.

677. *M. diffusa*, Schreber. Drop-seed. Nimble Will.
Dry, shady places. Local.

BRACHYELYTRUM, Beauv.

678. *B. aristatum*, Beauv.
Dry, open woods. Common.

PHLEUM, L. Cat's-tail grass.

679. P. PRATENSE, L. Timothy. Herd's-grass (in New Eng. and N. Y.)
The chief cultivated hay grass. Growing wild everywhere.

ALOPECURUS, L. Foxtail grass.

680. *A. geniculatus*, L., var. *aristulatus*, Torr. Floating foxtail.
Observed growing at the eastern margin of the lagoon on Picnic Point. Rare.

SPOROBOLUS, R. Br.

681. *S. asper*, Kunth.
Common in dry, sandy or gravelly soil.

682. *S. heterolepis*, Gray.
Growing along railroads. Rather rare.

683. *S. cryptandrus*, Gray.
Growing on high sandy ridge between Lakes Wingra and Monona. Not observed elsewhere.

AGROSTIS, L. Bent-grass.

684. A. ALBA, L. Fiorin or white bent-grass.
Not rare. In all grass and pasture land.

685. A. ALBA, L., var. VULGARIS, Thurb. Red top. Herd's-grass (of Penn.)
A very common and considerable element in all the pasture lands of the region.

686. *A. scabra*, Willd. Hair-grass.
Met with occasionally on dry soil. Not common.

687. *C. arundinacea*, L.
In shady places at margins of ponds. Local.

CALAMAGROSTIS, Adans. Reed bent-grass.

688. *C. Canadensis*, Beauv. Blue-joint grass.
Forming a very valuable and considerable element in the "wild hay" made throughout the region. Very common.

ARRHENATHERUM, Beauv. Oat-grass.

689. A. AVENACEUM, Beauv.
Persisting in places about Madison after cultivation. Not common.

BOUTELOUA, Lagasca. Muskit-grass.

690. *B. racemosa*, Lag.
On dry hills and rocky points. Rather local.

PHRAGMITES, Trin. Reed.

691. *P. communis*, Trin.
In all marshes about the lakes forming dense patches. Local.

KŒLERIA, Pers.

692. *K. cristata*, Pers.
Not uncommon in dry ground along railroads

ERAGROSTIS, Beauv.

693. *E. reptans*, Nees.
Growing in moist, sandy soil. Not abundant.

694. E. MAJOR, Host.
Becoming very common as a weed in cultivated or waste grounds.

695. *E. Purshii*, Schrader.
Rather common in hard, dry ground.

DACTYLIS, L. Orchard grass

696. D. GLOMERATA, L.
Persisting in many places on good soil after cultivation.

POA, L. Meadow-grass. Spear-grass.

697. P. ANNUA, L. Low spear-grass.
Moist, shady places. Rather common.

698. P. COMPRESSA, L. Wire-grass. English blue-grass.
Dry hillsides and along railroads. Not rare.

699. *P. serotina*, Ehrh. False red-top. Fowl meadow grass.
Widely distributed and rather common.

700. *P. pratensis*, L. June grass. Spear-grass. Kentucky blue-grass.
This is the most abundant and valuable of the spontaneous grasses in the region.

GLYCERIA, R. Br. Manna-grass.

701. *G. nervata*, Trin. Fowl-meadow grass.
Not uncommon in wet meadows and marshes.

702. *G. fluitans*, R. Br.
Growing in lagoon on Picnic Point. Not observed elsewhere.

FESTUCA, L. Fescue-grass.

703. *F. tenella*, Willd.
This species is found on dry, sandy and gravelly points about Madison. Not infrequent but rather local.

704. *F. nutans*, Willd.
Rocky woods and copses. Not common.

705. *F. elatior*, L., var. *pratensis*, Gray. Taller or meadow fescue.
Occurring occasionally in low, moist grass land. Not common.

BROMUS, L. Brome-grass.

706. *B. Kalmii*, Gray. Wild chess
In copses and along railroads. Rather rare

707. B. SECALINUS, L. Cheat or chess.
Widely distributed. Not especially abundant.

708. *B. ciliatus*, L.
Rocky woods and thickets. Common.

709. B. ASPER, L.
Growing in moist woods and copses. Rather common.

LOLIUM, L. Darnel.

710. *L. PERENNE, Common darnel. Ray-or rye-grass.
Observed growing spontaneously on the Univ. of Wis. farm and in several places in the city of Madison. Local.

AGROPYRUM, Gærtn.

711. ***A. repens*, Beauv. Couch, quitch or quick-grass.
Common in dry soil throughout the region.

712. *A. dasystachyum*, Vasey.
Found with *A. repens*. Rather rare.

HORDEUM, Tourn. Barley.

713. *H. jubatum*, L. Squirrel-tail grass.
Common in dry, waste places.

ELYMUS, L. Lyme-grass. Wild rye.

714. *E. Canadensis*, L.
Dry, gravelly or sandy embankments or slopes. Not rare.

715. *E. striatus*, Willd.
Open, rocky woods. Not common.

ASPRELLA, Willd. Bottle-brush grass.

716. *A. Hystrix*, Willd.
Dry, open woodlands. Rather common.

GYMNOSPERMÆ.

CONIFERÆ. (PINE FAMILY.)

PINUS, Tourn. Pine.

717. *P. Strobus*, L. White pine.
University campus. Cultivated. This species has doubtless been a native of this region, as it is still found on the hills at Pine Bluff.

718. P. RESINOSA, Ait. Red pine.
Near Lake Wingra. Cultivated.

719. ***P.* SYLVESTRIS, L. Scotch pine.
University campus. Cultivated.

PICEA, Link. Spruce.

720. P. nigra, Link. Black spruce.
Hook Lake.

721. *P. ALBA, Link. White spruce. (*Abies alba*, Michx.)
W. Johnson St., Madison. Cultivated.

TSUGA, Carriere. Hemlock.

722. **T. CANADENSIS, Carr.
Hedge on State St. Cultivated.

ABIES, Link. Fir.

723. **A. EXCELSA, Norway spruce.
University campus. Cultivated.

724. **A. BALSAMEA, Miller. Balsam or balm-of-Gilead fir.
University campus. Cultivated.

LARIX, Tourn. Larch.

725. **L. Americana*, Michx. American or black larch. Tamarack. Hackmatack.
University campus. Cultivated.
In wild state in marsh near Windsor; east of Lake Waubesa and at Hook Lake.

THUYA, Tourn. Arbor vitæ.

726. ***T. occidentalis*, L. Arbor vitæ. White cedar.
University campus. Cultivated.

JUNIPERUS, L. Juniper.

727. **J. Virginiana*, L. Red cedar or savin.
State street. Cultivated.
In wild state on rocky bluffs about the lakes.

PTERIDOPHYTA.

EQUISETACEÆ. (HORSETAIL FAMILY.)

EQUISETUM, L. Horsetail. Scouring rush.

728. **E. arvense*, L. Common horsetail.
In sandy and gravelly soil. Common along railroad tracks.

729. *E. limosum*, L.
Common in shallow water.

730. *E. robustum*, Braun.
Growing along the C. M. & St. P. R. R. south of Lakeside. Local.

731. *E. lævigatum*, Braun.
Not rare throughout the region.

FILICES. (FERN FAMILY.)

POLYPODIUM, L. Polypody.

732. **P. vulgare*, L.
Not rare on rocks along lakes.

ADIANTUM, L. Maiden hair.

733. **A. pedatum*, L.
Common in rich, moist woods.

PTERIS, L. Brake or bracken.

734. *P. aquilina*, L. Common brake.
Common in open woods and thickets.

PELLÆA, Link. Cliff-brake.

735. *P. atropurpurea*, Link.
On faces of rocks about the lakes. Local.

ASPLENIUM, L. Spleenwort.

736. **A. Felix-fœmina*, Bernh.
Rich woodlands. Not uncommon.

ASPIDIUM, Schwartz. Shield fern. Wood fern.

737. *A. Thelypteris*, Schwartz.
Very common in all the marsh lands about the lakes.

CYSTOPTERIS, Bernhardi. Bladder fern

738. *C. bulbifera*, Bernh.

Growing on the principal rock exposures about Lakes Mendota and Monona. Local.

739. *C. fragilis*, Bernh.

Shaded banks south of Lake Mendota. Rare.

ONOCLEA, L.

740. *O. sensibilis*, L. Sensitive fern.

Moist thickets and meadows throughout the region. Not uncommon.

OSMUNDA, L. Flowering fern.

741. **O. regalis*, L. Flowering fern.

But a single small specimen of this fern has been observed. This stands on the right bank of the little stream which forms the outlet of Lake Wingra, a few rods below the lake.

742. *O. Claytonia*, L.

Moist, rich woods. Not uncommon.

OPHIOGLOSSACEÆ. (ADDER'S-TONGUE FAMILY.)

BOTRYCHIUM, Schwartz. Moonwort.

743. *B. Virginianum*, Schwartz.

Found in all rich woodlands, though not abundant.

OPHIOGLOSSUM, L. Adder's-tongue.

744. *O. vulgatum*, L.

A few specimens collected on the low, sandy ridge northeast of Lake Wingra, about fifteen rods from the lake.

LYCOPODIACEÆ. (CLUB-MOSS FAMILY.)

LYCOPODIUM, L. Club-moss.

745. *L. lucidulum*, Michx.

South of Fish Hatcheries. Rare.

BRYOPHYTA.

MUSCI. (THE MOSSES.)

SPHAGNACEÆ. (PEAT MOSSES.)

SPHAGNUM, Dill. Peat moss.

746. *S. Girgensohnii*, Russ. (*S. strictum*, Lindb.)
A small tuft of this moss was collected at the margin of a marshy meadow about one mile north of Mendota station. Rare.

747. *S. molle*, Sulliv.
Rare, one small specimen collected at the edge of a small pond one mile east of Lake Monona.

748. *S. cymbifolium*, Ehrh.
Only a small dwarfed tuft collected from the margin of Lake Mendota a few rods east of Mr. Fuller's woods. Rare.

BRYACEÆ. (TRUE MOSSES.)

PHASCUM, Linn., in part.

749. *P. cuspidatum*, Schreb.
On fallow ground. Common.

PLEURIDIUM, Brid.

750. *P. alternifolium*, Brid., in part.
In pastures and clover fields. Common.

ASTOMUM, Hampe.

751. *A. Sullivantii*, Schimp.
On ground in grass lands. Common.

GYMNOSTOMUM, Hedw.

752. *G. calcareum*, Nees & Hornsch.
On jutting rocks, south shore of Lake Mendota. Rare.

753. *G. rupestre*, Schwaeger.
Collected from the face of the cliff, Maple Bluff. Not common.

754. *G. curvirostrum*, Hedw.

Common about the lakes on rocks overhanging the water.

Weisia, Hedw.

755. *W. viridula*, Brid.

Common on the ground.

Dicranella, Schimp.

756. *D. varia*, Schimp.

On the ground. Rex Magnus, Picnic Point, on Lake Mendota; Schuetzen Park, Lake Monona. Not common.

757. *D. heteromalla*, Schimp.

Collected at Second Point and Merrill Springs, on Lake Mendota; at McFarland; and along the C. & N. W. R. R. southwest of Madison. Not uncommon.

Dicranum, Hedw.

758. *D. montanum*, Hedw.

On decaying logs in woods north of Mendota, south and west of Madison, and east of McFarland. Not uncommon.

759. *D. viride*, Schimp.

Growing on a stone close to the ground in woods along I. C. R. R. northwest of Forest Hill Cemetery. Rare. Always sterile.

760. *D. flagellare*, Hedw.

On decaying wood in a swamp near Windsor; on a log in woods east of Madison, and in a similar place south of Madison. Not common.

761. *D. scoparium*, Hedw.

Rich woods west of Lake Wingra, woods east of Lake Monona, tamarack swamp near Windsor, and along the lake shore a few rods east of Fuller's Woods. Not rare.

762. *D. Bonjeani*, De Not.

Sterile. Typical in leaf and cells. On ground near Mendota. A form varying but slightly from the species is common in low woods at margins of marsh lands.

763. *D. Bonjeani.* De Not., var. *alatum*, Barnes.
On damp ground near Mendota. Rare.

764. *D. Bonjeani*, De Not., var. *Schlotthaueri*, Barnes.
Good specimens agreeing with the type specimens of this variety in all points except the slightly larger size of the former were collected at Hook Lake. Rare.

765. *D. Schraderi*, Web. & Mohr.
In a tamarack swamp near Windsor. Local.

766. *D. Drummondii*, Muell.
A single small tuft found growing at the edge of a shallow pond one mile east of Lake Monona.

767. *D. undulatum*, Turn.
Growing on the ground in woods west of Lake Wingra, along the Mineral Point road four miles west of Madison, in the woods a mile and a half northeast of Mendota, and in the woods east of Lake Monona. Not abundant.

FISSIDENS, Hedw.

768. *F. bryoides*, Hedw.
On damp ground in woods. Not rare.

769. *F. incurvus*, Schwægr.
On moist rock surfaces about Lake Mendota and on the stones in the bed of an intermittent stream two miles west of Madison. Not uncommon.

770. *F. adiantoides*, Hedw.
Found growing on the ground in a low, wet grove four miles northeast of Madison, along the C., M. & St. P. R, R.; east of Lake Monona; and near the I. C. R. R. northwest of the cemetery. Not common.

LEUCOBRYUM, Hampe.

771. *L. vulgare*, Hampe.
Marshy land northeast of Lake Waubesa; tamarack swamp near Windsor; edge of marsh northeast of Mendota, and rich woods west of Lake Wingra. Not rare.

CERATODON, Brid.

772. *C. purpureus*, Brid.
On the ground. Common everywhere.

LEPTOTRICHUM, Hampe.

773. *L. tortile*, Muell.
On ground and on sandstone faces at Merrill Springs. Not common.

774. *L. tortile*, Muell., var. *pusillum*, Schimp.
On ground at Experiment Station Farm.

DESMATODON, Brid.

775. *D. arenaceus*, Sulliv. & Lesq.
This species occurs in abundance on the rock exposures about Lake Mendota. It was collected at the northwest extremity of Lake Kegonsa, and from the old exposures at the quarries west of Madison. Local.

BARBULA, Hedw.

776. *B. unguiculata*, Hedw.
On ground, very common, especially in low, moist soil.

777. *B. fallax*, Hedw.
This moss grows with *Desmatodon arenaceus* and was collected in all localities from which that species was obtained. It was obtained, also, from old tombstones in Forest Hill cemetery. Local.

778. *B. mucronifolia*, Bruch & Schimp.
Forming cushions on ground in open woods. Near Mendota Heights; at Second Point; also at the lake shore east of Lakeside, and along the northwest shore of Lake Kegonsa. Not rare.

GRIMMIA, Ehrh.

779. *G. apocarpa*, Hedw.
On limestone west of Madison; not common.

780. *G. plagiopoda*, Hedw.
Not rare on granitic boulders along C. M. & St. P. R. R. near Stevens' quarries.

781. *G. Donniana*, Smith.

Growing on a fragment of limestone on a stony point north of C. M. & St. P. R. R. near Stevens' quarries.

HEDWIGIA, Ehrh.

782. *H. ciliata*, Ehrh.

Not rare on boulders throughout the region.

783. *H. ciliata*, Ehrh., var. *viridis*, Schimp.

On granite erratic near Merrill Springs.

ULOTA, Mohr.

784. *U. crispa*, Brid.

Growing on granitic boulders near C. & N. W. R. R. four miles east of Madison; near the State Fish Hatcheries, and two miles west of Madison. Not common.

ORTHOTRICHUM, Hedw.

785. *O. anomalum*, Hedw.

Growing on boulders near Rex Magnus; at Eagle's Nest, and east of Lake Monona. Not common.

786. *O. cupulatum*, Höffm.

In U. W. herbarium, collected at Madison by T. J. Hale.

787. *O. affine*, Schrad.

On boulder beside the Mineral Point road six miles west of Madison. Rare.

788. *O. speciosum*, Nees.

On granitic boulders east of Lake Monona; along Mineral Point road four miles west of Madison, and near Eagle's Nest.

789. *O. Ohioense*, Sulliv. & Lesq.?

A specimen collected on the University campus which differs from the description in some minor points has been inserted under this name.

790. *O. strangulatum*, Beauv.

Very common on the bark of trees, on decaying logs, and occasionally on stones throughout the region.

TETRAPHIS, Hedw.

791. *T. pellucida*, Hedw.
On decaying stumps in tamarack swamp near Windsor. Local.

PHYSCOMITRIUM, Brid.

792. *P. pyriforme*, Brid.
Common on the ground throughout the region.

FUNARIA, Schreb.

793. *F. hygrometrica*, Sibth.
On ground, everywhere.

BARTRAMIA, Hedw.

794. *B. pomiformis*, Hedw.
A single, small tuft collected from rock exposure near I. C. R. R. two miles west of Madison. Rare.

PHILONOTIS, Brid.

795. *P. fontana*, Brid.
Growing in springy place at the margin of a marsh near Windsor.

796. *P. calcarea*, Schimp.
In a number of small calcareous springs at Merrill springs. Excellent specimens of this moss were collected, all in sterile condition.

LEPTOBRYUM, Schimp.

797. *L. pyriforme*, Schimp.
Common on ground. On limestone foundation of Library Hall, University of Wisconsin.

WEBERA, Hedw.

798. *W. nutans*, Hedw.
Growing on the ground at Hook Lake.

799. *W. albicans*, Schimp.
Growing in a wet, sandy place near the lake shore between Picnic Point and Second Point. Sterile. Rare.

BRYUM, Dill.

800. *B. pendulum*, Schimp.
On ground forming cushions. Common.

801. *B. pendulum*, Schimp., var. *angustatum*, Renauld.
At the base of a tree in a small wood lot south of the I. C. R. R. near Forest Hill cemetery. Rare.

802. *B. inclinatum*, Bruch & Schimp.
Forming small, dense cushions on the ground throughout the region. Not rare.

803. *B. uliginosum*, Bruch & Schimp.
One small specimen collected from the wooded slope north of Hook Lake.

804. *B. bimum*, Schreb.
Growing on sandy soil near Hook Lake. Not common.

805. *B. argenteum*, Linn.
Common on ground, especially in dry, sandy places. On rocky, dry hills west of Madison.

806. *B. cæspiticium*, Linn.
A single specimen collected at Hook Lake. Not common.

807. *B. roseum*, Schreb.
At bases of trees and on decaying wood throughout the region. Rather common. Rare in fruiting stage. Collected in fruit at a big spring south of Lake Wingra and in the woods west of Stevens' quarries.

MNIUM, Linn.

808. *M. cuspidatum*, Hedw.
On ground in shady places. Common.

809. *M. rostratum*, Schwægr.
Growing in a damp place near the edge of pond one mile east of Lake Monona. Not common.

810. *M. ffiane*, Bland.
Shady, damp bank one mile north of Mendota Station. Low, wet woods four miles southwest of of Madison, near I. C. R. R., and muddy bank of the Yahara river just below Lake Kegonsa. Not rare.

811. *M. serratum*, Laich.
With *M. affine*, on damp, shady bank one mile north of Mendota Station. Not common.

AULACOMNIUM, Schwægr.

812. *A. palustre*, Schwægr.

Not rare at the margins of marshes and wet meadow lands throughout the region.

TIMMIA, Hedw.

813. *T. megapolitana*, Hedw.

Not rare. On ground at Merrill Springs; moist, shady bank one mile north of Mendota Station, and on wet rocks at Stevens' quarries.

ATRICHUM, Beauv.

814. *A. undulatum*, Beauv.

Common in open woods on ground. Variable.

815. *A. angustatum*, Bruch & Schimp.

On ground near lake shore, between Picnic Point and Second Point; in the woods along the I. C. R. R. Near Forest Hill Cemetery. Not rare.

POLYTRICHUM, Linn.

816. *P. gracile*, Menz.

Collected at Eagle's Nest. There is also a specimen in U. W. herbarium, collected by S. H. Watson. Not common.

817. *P. juniperinum*, Willd.

Abundant on ground about the lakes and on sandy wooded hillsides.

818. *P. strictum*, Banks.

On ground at stone quarry west of Madison, and in woods at the margin of marsh along the C. M. & St. P. R. R. near Burke. Local.

819. *P. commune*, Linn.

On ground in shady places about the lakes. Not rare.

820. *P. Ohioense*, Renauld & Cardot, Bot. Gaz., 1888.

Collected along the shore of Lake Mendota a few rods east of Fuller's woods. Not common.

NECKERA, Hedw.

821. *N. pennata*, Hedw.

Rare, but one small specimen being found in the woods half a mile southeast of Forest Hill cemetery.

THELIA, Sulliv.

822. *T. hirtella*, Sulliv.

On base of trees. In woods south of Lake Wingra. Rare.

823. *T. asprella*, Sulliv.

Growing on the bases of trees, on decaying stumps and logs and occasionally on the ground. Common.

LESKEA, Hedw.

824. *L. obscura*, Hedw.

Common on trees and rocks near the ground.

825. *L. Austini*, Sulliv.

This beautiful little moss is common throughout the region. It grows in the chinks of the bark of trees, usually preferring the elm, but not uncommonly found on other trees. It is not common in fruit, having been found in this condition in but one locality, the woods along the I. C. R. R. southeast of Forest Hill Cemetery.

ANOMODON, Hook & Tayl.

826. *A. rostratus*, Schimp.

Rather common growing on the bases of trees.

827. *A. attenuatus*, Hueben.

On bases of trees at Merrill Springs. Rare.

828. *A. obtusifolius*, Bruch & Schimp.

Our commonest species of *Anomodon*. It is found growing on the bases of trees in moist places. Usually sterile.

PLATYGYRIUM, Bruch & Schimp.

829. *P. repens*, Bruch & Schimp.

On decaying logs and stumps in woods. Common.

PYLAISÆA, Bruch & Schimp.

830. *P. polyantha*, Bruch & Schimp.

Collected in the woods across the road from the Wisconsin State Fish Hatchery, and from a log in the fence beside the Mineral Point road six miles west of Madison.

831. *P. subdenticulata*, Schimp.
Growing on trees in the woods near Forest Hill cemetery; in woods southwest of Lake Monona, and on the lake shore near pump house, University of Wisconsin.

832. *P. intricata*, Bruch & Schimp.
Common on trees and logs. Found also on crumbling limestone and on the ground.

CYLINDROTHECIUM, Bruch & Schimp.

833. *C. cladorrhizans*, Schimp.
Common on bases of trees, and on logs, and on rocks.

834. *C. seductrix*, Sulliv.
On bases of trees and logs. Not so common as *C. cladorrhizans*.

835. *C. compressum*, Bruch & Schimp.
On decaying stump, Picnic Point. Very rare.

CLIMACIUM, Web. & Mohr.

836. *C. Americanum*, Brid.
Rather common; on ground in moist woods. Usually sterile. Fruiting abundantly in the low, wet woods about the northeastern extremity of Lake Waubesa.

HYPNUM, Dill.

Thuidium.

837. *H. minutulum*, Hedw.
Growing on the bases of trees in woods west and southwest of Madison. Rather local.

838. *H. scitum*, Beauv.
Collected in small wood lot south of the I. C. R. R. near Forest Hill Cemetery. Growing on the base of a tree.

839. *H. gracile*, Bruch & Schimp.
Very common on the ground and on the bases of trees throughout the region.

840. *H. recognitum*, Hedw.
On the ground near Windsor. One tuft only was found. Rare.

841. *H. delicatulum*, Linn.
On the ground in rich, moist woods and on the bases of trees. Common throughout the region.

842. *A. paludosum*, Sulliv.
Among grass in edge of marsh near Windsor. Probably occurring often in such places.

Brachythecium.

843. *H. lætum*, Brid.
On the ground; common on damp, shady banks. Very variable.

844. *H. acuminatum*, Beauv.
Very common at the roots of trees.

845. *H. salebrosum*, Hoffm.
Growing on the ground in moist, shady places. Common.

846. *H. salebrosum*, Hoffm., var. *palustre*, Lesq. & James.
In marshes, growing among the grass. Merrill Springs. Marsh south of Madison.

847. *H. acutum*, Mitt.
Found growing at the edge of small marsh along the C., M. & St. P. R. R. near Burke, and at Washburn Springs. Not common.

848. *H. rutabulum*, Linn.
A single specimen found on the ground in low, wet thicket along the Montfort branch of the C. & N. W. R. R. two miles southwest of Madison. Rare.

Eurhynchium.

849. *H. hians*, Hedw.
Collected at the margin of a small marsh near the Montford branch of the C. & N. W. R. R. two miles southwest of Madison. Not rare.

Rhynchostegium.

850. *H. serrulatum*, Hedw.
In open woods, forming patches at base of trees, and on the ground. Common throughout the region.

Plagiothecium.

851. *H. sylvaticum*, Huds.
Growing on the ground in woods on the left bank of Yahara river, three miles northeast of Mendota, and on the ground in thicket northeast of Lake Monona. Not common.

852. *H. denticulatum*, Linn.
Common on the ground and decaying wood in moist woods.

Amblystegium.

853. *H. serpens*, Linn.
On the ground, everywhere.

854. *H. radicale*, Beauv.
Plants agreeing quite closely with the European *Amblystegium* are common throughout the region. It is probable, however, that they will prove to be *A. varia*.

855. *H. orthocladon*, Beauv.
Specimens of this plant were collected at Washburn Springs, along the lake shore east of Fuller's woods, east of Lake Monona and at McFarland. Not common.

856. *H. irriguum*, Hook. & Wils.
Growing on the ground about Washburn Springs and about the large springs on the south side of Lake Wingra. Not common.

857. *H. irriguum*, Hook. & Wils., var. *spinifolium*, Lesq. & James.
In most calcareous springs throughout the region. Collected in the fruiting stage in a large spring south of Lake Wingra and in one of the springs on the south side of the lake.

858. *H. adnatum*, Hedw.
Growing on stones and at the bases of trees in woods. Not rare.

859. *H. compactum*, Muell.
On calcareous soil at the base of Maple Bluff. Rare.

860. *H. riparium*, Linn.
In wet places on stumps, logs, sticks, etc. Near lake shore, McFarland, and at the edge of pond near Mineral Point road, six miles west of Madison.

861. *H. riparium*, Linn., var., *flaccidum*, Lesq. & James.
Growing with the species and mnch more common. Distributed throughout the region.

Campylium.

862. *H. hispidulum*, Brid.
Growing on the bases of trees and on the ground in all the woods of the region.

863. *H. chrysophyllum*, Brid.
This plant is not uncommon about the quarries and on sandy soil west of Madison.

864. *H. stellatum*, Schreb.
Collected at the edge of a marsh one mile northeast of Mendota Station and in the marsh west of University Bay. Not common.

Harpidium.

865. *H. aduncum*, Hedw., var. *polycarpum*, Bruch & Schimp.
Collected from a large spring south of Lake Wingra. One of the less common varieties of this species.

866. *H. aduncum*, Hedw., var. *gracilescens*, Bruch & Schimp,
Very abundant in spring ground at Merrill Springs. Somewhat local.

867. *H. aduncum*, Hedw., var. *tenue*, Bruch & Schimp.
Several specimens of this variety were collected near the Wisconsin State Fish Hatchery. It is doubtless common in low meadows.

868. *H. aduncum*, Hedw., var. *hamatum*, Lesq. & James.
The form that we have listed as this variety is very abundant in all submerged marsh land along the lakes, and in ditches along roads and railroads, and has a wide range of variation.

869. *H. uncinatum*, Hedw.

Of this plant only one small tuft was collected. This was found on a decaying log beside the road six miles west of Madison. Rare.

870. *H. filicinum*, Linn.

On the ground in a bog at Merrill Springs. Growing with *Philonotis calcarea.* Rare.

Ctenium.

871. *H. crista-castrenis*, Linn.

On the ground in woods at the margins of swamps. Widely distributed. Rare in fruit.

Hypnum.

872. *H. reptile*, Michx.

Forming wide, close-adhering patches on granitic rocks. Everywhere.

873. *H. imponens*, Hedw.

Collected on a log near the road from Stoughton to Oregon, five miles east of the former place. Rare.

874. *H. cupressiforme*, var.

A few small specimens of this moss were found at the Wisconsin State Fish Hatchery. Not common.

875. *H. Haldanianum*, Grev.

Woods near lake shore one mile east of the village of Pheasant Branch. Growing on a log. Not common.

876. *H. arcuatum*, Lindb.

This is one of our commonest mosses. It forms wide mats in marshy meadows and in low, wet woods. Not common in fruiting condition.

Calliergon.

877. *H. cuspidatum*, Linn.

In marsh west of Lake Wingra. Rare.

878. *H. Schreberi*, Willd.

Growing with *H. crista-castrensis.* Less common. Rare in fruit.

Hylocomium.

879. *H. triquetrum*, Linn.
With the preceding. Much less common. Usually sterile.

HEPATICÆ. (LIVERWORTS.)

JUNGERMANNIACEÆ. (SCALE MOSSES.)

FRULLANIA, Raddi.

880. *F. Eboracensis*, Lehm.
Growing on north side of trees. Common throughout the region.

881. *F. Asagrayana*, Mont.
With the preceding. Less common.

PORELLA, Dill.

882. *P. platyphylla*, Lindb.
On stumps and rocks and at the base of trees in moist places. Common.

PTILIDIUM, Nees.

883. *P. ciliare*, Nees.
A small specimen was collected along Mineral Point road six miles west of Madison. Rare.

LOPHOCOLEA, Dumort.

884. L. *bidentata*, Dumort.
On decaying wood in moist places. Not rare.

ANTHOCEROTACEÆ. (HORNED LIVERWORTS.)

ANTHOCEROS, Micheli.

885. *A. lævis*, L.
Growing on the ground in moist, grassy places and on wet rocks. Not rare.

NOTOTHYLAS, Sulliv.

886. *N. orbicularis*, Sulliv.
Growing on the ground with the preceding.

MARCHANTIACEÆ. (LIVERWORTS.)

MARCHANTIA, Marchant. f.

887. *M. polymorpha*, L.
In damp, shady places; very common everywhere.

PREISSIA, Nees.

888. *P. commutata*, Nees.

On overhanging rocks about Lake Mendota.

CONOCEPHALUS, Neck.

889. *C. conicus*, Dumont.

Very abundant on the faces of cliffs about the lakes, near the water, and not rare on the ground in wet places. Rare in fruit.

ASTERELLA, Beauv.

890. *A. hemisphærica*, Beauv.

On overhanging rocks about Lake Mendota.

GRIMALDIA, Raddi.

891. *G. barbifrons*, Bisch.

On the ground on dry, gravelly hillsides. Wingra Lake; ridge and hills near quarry two miles south of Madison.

Ricciaceæ.

RICCIA, Micheli.

892. *R. arvensis*, Aust.

Growing on ground in cultivated field. Common.

893. *R. fluitans*, L.

In springs about the lakes. Local.

894. *R. natans*, L.

In the quiet parts of the lakes and in ponds throughout the region.

ADDENDA.

LECHEA, Kalm. Pinweed.

895. *L. minor*, L.
Sandy knoll south of Eagle's Nest.

896. *Vaccinium macrocarpon*, Ait. Large or American cranberry.
Peat bog, Sec. 36, town of Madison.

897. *Ulmus racemosa*, Thomas. Corky white elm.
Governor's Island. Rare.

898. *Pellœa gracilus*, Hook.
On a damp sandstone exposure near Eagle's Nest. Rare.

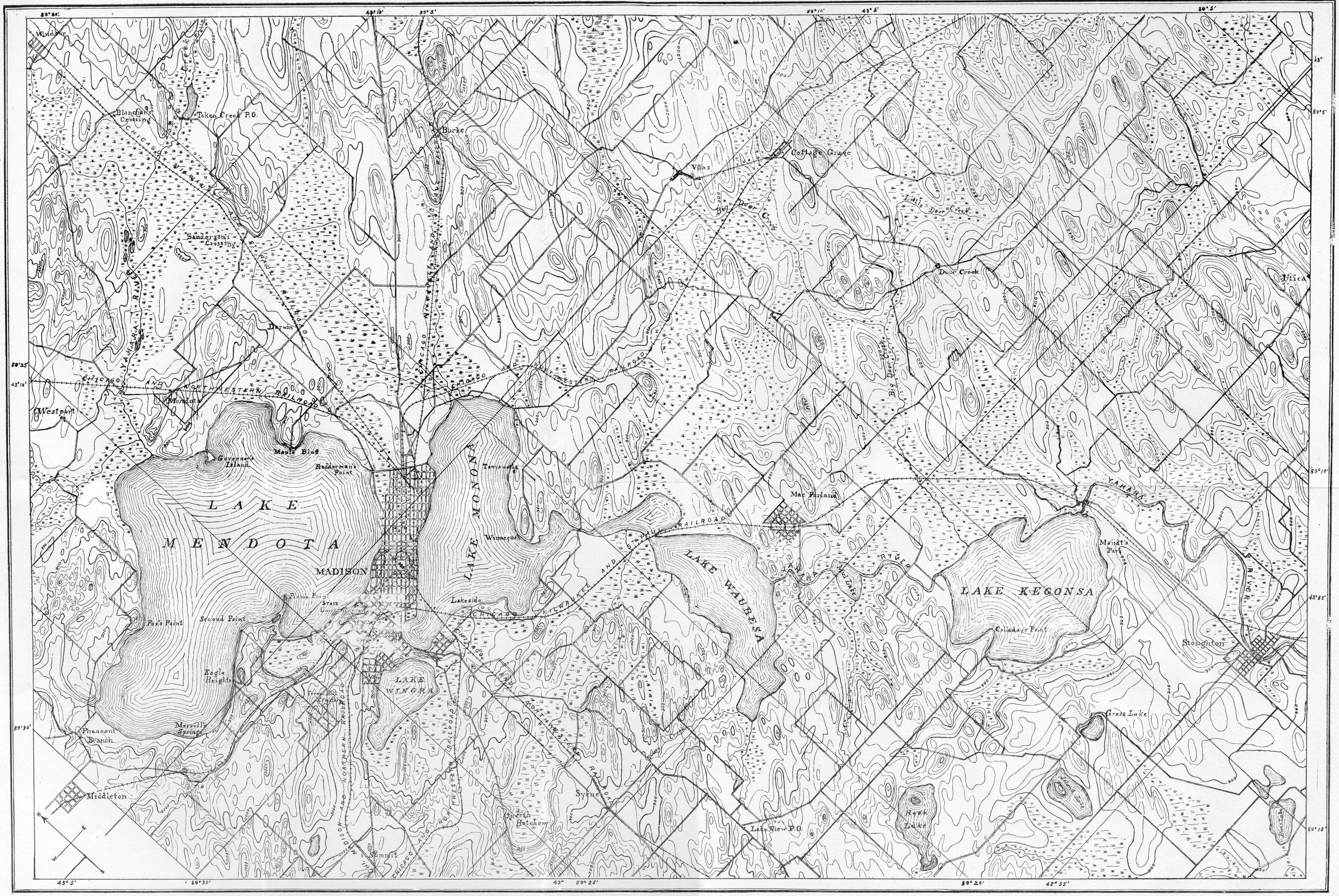
899. *Lycopodium clavatum*, L. Common club-moss.
A single specimen found on the northwest shore of Hook Lake. Rare.

900. *Leskea polycarpa*, Ehrh.
On decaying wood south of Forest Hill Cemetery Not rare.

ERRATA.

On page 52, instead of POLYPETALÆ, read DICOTYLEDONES.

On page 52, instead of DICOTYLEDONES, read POLYPETALÆ.



Contour Interval 20 feet.

MAP OF THE FOUR LAKES COUNTRY, WISCONSIN.

Scale. 0 1 2 3 Miles.

Cheney and True.

THE DIRECTION OF SOCIAL REFORM.

By David Kinley, Madison.

With the classification of Sociology as a department of Biology, an important change has been wrought in the common view of the nature and mode of growth of society. The "social body" is regarded as, in some sense, an organism developed under varying conditions from pre-existent forms. It is now recognized that social progress consists in a continual readaptation to changed and changing environment, the nature of which is such as to produce a more complex structure, or an organism of higher order. The nature of the institutions of a people depends, as is now well understood, on the character of the people, on climate, mode of life, and a score of lesser influences.

The changes of conditions, or environment, which hitherto have induced changes in the social structure, have been in the main spontaneous. They have not, generally speaking, been the result of a preconceived purpose on the part of men to attain an ideal. Whatever changes men have made have been, so to speak, remedial rather than formative; to meet present exigencies rather than to construct a new social fabric. The result of human action has been to put experience into laws, which roughly mark the boundaries of civilization rather than constitute its expansive force. In short, "blind evolution" has been the chief motive power of change. As, however, knowledge of the laws underlying human life in society increases, it should become more and more possible for men to guide these laws for the accomplishment of a preconceived purpose; so to change the conditions under which they operate as to direct their movement to the attainment of an ideal.

Social and economic conditions have come to be, in a large and an increasing degree, under human control. The change of the environment is no longer the result of forces wholly unregulated by human action, but of forces working under conditions imposed by the will of man. In the one set of circumstances, social problems worked themselves out under the law of survival of the fittest; in the other, they are worked out by the establishment of conditions which will evolve, or create, the life or organism which is deemed to be the fittest. They formerly fought themselves out, now they may be thought out. That is to say, *reform* is added to spontaneous evolution as a means of social progress. But reform is itself evolutionary It is but evolution under guidance. The spontaneous evolution is purposeless, at least so far as man is concerned; reform is purposeful. One is unconscious; the other, conscious. Yet both are evolution. For man cannot prevent the operation of natural laws. He can only guide, control, direct them. All his efforts to consummate his purpose must be under their operation. The laws themselves remain, but the conditions under which they operate may change or be changed, so as to produce different results. This is a general truth. It is true in physics as well as in sociology. The electric current which under one set of conditions turns machinery, under another gives us light. It is the same current, generated and flowing under the operation of the same laws, but through a different medium. So the sociologist, or the practical economist, may so adjust the conditions of taxation, for example, as to produce very varied social results. Yet the same general laws directing the "incidence of taxation" will still operate. Taxation, like any other force, follows the line of least resistance. "Taxation may create monopolies or it may prevent them; it may diffuse wealth or it may concentrate it; it may promote liberty and equality of right or it may tend to the establishment of tyranny and despotism; it may be used to bring about reforms or it may be so laid as to aggravate existing grievances and foster dissension and hatred between classes; taxation may be so contrived by the skilful hand as to give free scope to every opportunity for the creation of wealth or for the advancement of all true interests of states and cities, or it may be so shaped as to place a dead weight on a community in the race for industrial supremacy."*

At this point, as it seems, practical economists and social reformers are in danger of making two mistakes. In the first place, the language used to deny economic perpetualism and cosmopolitanism seems, in some instances, rather strong. The idea has at times been conveyed that economic *laws* are variable; that the laws *underlying* the economic and social development of one time or nation, are different from those by which the life of another time or nation has been moulded. But this, surely, is a false view. Economic laws, properly considered, are "natural laws" or laws of nature, for they are expressive of relations of cause and effect. Given the same economic or social conditions, the same results must follow. Such are the "laws" of physics, of chemistry, and of every other science. The law of gravitation tells us that a body is attracted to the earth with a force that varies as the mass and the inverse square of the distance. The fact that a body of given dimensions has a different weight at the sea-level on the equator from what it has on the same level at the poles, does not prove the law false or inoperative. Other factors have entered the problem. It is the same law acting under different conditions—the law constant and universal, the media through which it operates, variable, temporary or local. So of economic and social laws. They are as truly "natural" as the laws of physics in their universality of time and place. But national characteristics and institutions differ; geographical, climatic, and natural industrial opportunities and conditions differ. And so the same laws work out different results. There are "diversities of operations," but the same laws.

The other mistake, which is really a corollary of this one, consists in the application of empirical plans for the cure of social ills. Two features of the present period will strike the future historian with astonishment. One is the great number of schemes proposed for social reform; the other, the large number of intelligent and educated people who believe in one

* Ely: Taxation in American States and Cities, p. 55.

or another of them. The wrecks of these schemes strew the world's pathway for more than a generation, though most of them contain some of the elements necessary to success. The very fact of their conception and existence, the very fact that they have been so earnestly believed in by so many intelligent people, emphasizes the fact of the existence of a social question more than could be done by any recital of its causes or its details.

On the other hand, the fact that so many of these schemes have been shattered on the hard rocks of real life is the best of evidence that they did not conform to the conditions of social growth. It is not enough for successful reform that wrong exists. It is not enough that the wrong is recognized, or that plans are made for its removal or its cure. The plans themselves must be framed in conformity with the laws of social growth if it is desired to construct them so as to insure success. To do so requires the scientific consideration of the mode of development of social life. Reform must learn from evolution. Present conditions are not absolute. Society is a growth, its life, a continuity. The present depends on the past, is conditioned by the past. Any new institution, then, must have a vital historical connection with those already existing. To attempt to introduce one under any other circumstances would be like trying to set a house on a new foundation without regard to the size, shape or strength of the foundation.

The inevitable result of any such attempt is to produce social jars, discontent, and wrong. This is not mere theory. It has been proved in history again and again. One of the most notable instances is the settling of the English legal and land-tenure systems on India. The law of Hindoo society is so unlike that of England that it could not, so to speak, be squeezed into the English legal framework without great injustice and distress. It is too vague to conform to English strict legal formulas. Sir Henry Maine says, on this subject: There is no doubt that the establishment of a tribunal on similar principles [as the English courts] would now-a-days be regarded as a measure of the utmost injustice and danger."*

* Village Communities, p. 37.

Maine recalls Macaulay's description, in his essay on Warren Hastings, of the consternation caused in India by the introduction of the English courts. The injustice in the case described by Macaulay was not that the prisoner did not have a fair trial from the point of view of English law; it was that "the introduction of the law under which he suffered was felt as a general grievance."

The historical explanation of the friction was that in India law had not yet become differentiated from religion, certainly not to the same extent as in England. English legal development was far in advance.

As to the system of land tenure, the English, being accustomed to large estates and great landlords, made the mistake of supposing that the same must exist in India. Neglecting the actual historical conditions they instituted such a system, conferring the large estates on tax gatherers, or "zemindars," as the class most nearly corresponding to the English landlords. The purpose was to put an end to the irregular exactions to which the peasants had long been subjected. The opportunity to establish a system "worthy to be ranked among the noblest that were ever taken for the improvement of any country" was blindly thrown away. The measure adopted proved a total failure, in its main feature. Its promoters were unaccustomed to allow for modification in the operation of new institutions under the influence of pre-existing conditions.

Similar results followed the attempt of our own forefathers to impose their systems of law and morals on the Indians.*

This same lack of adaption of the new to the old institutions is the reason that so many laws are unenforced. To be effective, a law must express the opinions of a majority, at least, of the people. Law can never be far in advance of public opinion, if it is to be enforced. It may be somewhat in advance; and it must be so, if it is to be a means of education. But it cannot serve this purpose unless it is expressive of the opinion of at least a respectable minority.

Any new system, whether legal, social, economic or political, must have reference, in the first place, to the character of

* See Weeden's Economic History of N. E., Vol. I, p. 27 ff.; also II, pp. 715 and 728.

the people. Our forefathers showed their character in their refusal to submit to taxation without representation. "Our Indian subjects," said Macaulay, "submit patiently to a salt monopoly. We tried a stamp duty—a tax so light as scarcely to be felt—on the fierce breed of the old puritans, and we lost an Empire." Bagehot had this same truth in mind when, after pointing out certain faults in our political system, he explained its working success by remarking that the American people could run any system. There are not many peoples of whom this would be true. For example, an attempt to govern Turkey by the American Constitutional system would invite only ridiculous failure. There are races which, at least so far in their development, seem incapable of self-government. Certainly no other people shows such a capacity for it as the Anglo-Saxons. The frequent convulsions which have taken place among the Latin peoples suggest the inquiry whether they have the faculty in any eminent degree. The legislators of even republican France come dangerously near making government a farce.

But even if we grant that all people have, or may develop, a sufficient character for self-government, their stage of development may render them incapable of it at the selected time. This suggests the second condition which schemes of reform must observe: They must be adapted to the stage of development reached by the people. This lack of equality of development was doubtless the cause of the hardships produced in India by the introduction of the English legal system, as noted above. To the same cause was probably due, in part, the ruin and distress, "for which no parallel can be found in the annals of commerce,"* that followed the introduction of the English system of manufacturers into India. The necessity of observing this condition of reform is also the explanation of the ill-success of attempts at revolution in Russia. The mass of the people is not yet educated up to the plane of self-government and the existing tyranny will endure until the majority of the Russian people are sufficiently developed to appreciate a better system; and the successful introduction of any better system will be

* Bentinck.

impossible until then. It wouldn't *work.* For institutions do not run themselves. They require the vital personality of a people behind them and within them. "A nation cannot leap several centuries of development." If it could, it would be possible to construct a state artificially. But no form of state has ever artificially existed, and none can so exist.

To say that in reform regard must be had to the stage of development, is to emphasize the importance of the average general education. There always is, in a country, a small number of people in advance of the rest. The masses cannot go as fast as the thinking portion of the community. But development, or progress, must wait on the body of the people. A new régime must be on the intellectual level of the people in general, if it is to be accepted and successful. It is for some such reason as this that the purity of the ballot has deteriorated in some places. The voters are not sufficiently educated to understand its value and importance. Similarly, it is claimed, the negroes in some sections of the south, have so little correct conception of their political rights and duties, that they are incapable of self-government; and our political institutions, left to management like theirs, would soon go to ruin.

Again, new institutions must be in the line with the historical development of a people. At present we in this country are having Germany held up to us as, in many respects, an institutional model. We hear of the "model city" of Berlin. We are told of its excellent municipal administration, and have the government of our own cities held up in contrast. This contrast is, indeed, both real and painfully impressive. But it would be rash to conclude that the Berlin system could be successful in London or New York, or even in Boston. Its successful introduction would require a change not only in the temper of our people, but, what amounts to the same thing, in the spirit of our institutions. Americans and Englishmen would not submit to what seems to us like the excess of bureaucratic or administrative authority. The docile German spirit of respect for "the powers that be," is lacking. "We are more tenacious of our political rights than observant of our political duties." This is, in some respects, a vicious spirit, but it is the spirit that has won us our liberties. It is true, indeed, that our liberties are now so secure that probably no extension of administration could affect them. And, moreover, the social and industrial conditions of the more advanced nations are becoming more and more alike. But we are yet far from the stage of identity.

Moreover, supposing it is in keeping with the character, education, and development of the people, a new institution requires for its successful operation time to adjust itself to its surroundings. Institutions, like nations, cannot be built in a day. Haste here makes not only waste but hardship and suffering. One of the best illustrations of this need of time for adjustment, is furnished by the history of internal taxation in our Civil War. The system was novel to our institutions, and the time required for it to get into complete touch with the life of the people was such that, being imposed some time after the beginning of the war, it yielded little help compared with what it might have afforded if established two or three years earlier. "The system of internal duties then established did not get well under way till late in 1863. The revenue from this source amounted for the four years *after* the close of the war, to over three times what it did for the four preceding years." * There is no doubt that the largest influence producing this result was the one indicated.

We cannot, then, successfully impose ready-made institutions on society. Any attempt to do so will result only in the ruin of the institutions and in great hardship to the people.

Not only must new institutions have relation to those already in existence, but they must be made to evolve from our old. But we "cannot evolve what has not first been involved." We must, then, to construct intelligently, study the nature of society. We must learn the manner of its growth.

It is the testimony of history that social growth is not equable. Society, in a given period, as a generation, or a century, develops more rapidly along some lines than along others. Progress is unsymmetrical, disjointed. Not all departments of activity move forward at the same rate. Having

* H. C. Adams: Public Debts, page 84.

advanced to a higher plane in one department, mankind must pause there to bring the others up to the same, or rather a harmonious, level. It is this fact which contains the truth expressed in the common remark that each nation and generation has its special mission. This same fact is illustrated by the progress of civilization in the last few centuries. The economic conditions existing under the Feudal System were well adapted to the social and religious situation. When progress began, it was not along all lines at once. It took the form of religious change. The most palpable and immediate result was not primarily a reform of ethics, or of religion itself. Speaking broadly, the movement was simply an attempt to secure individual independence of thought in theological matters. It was an emphasis of the importance of the individual. Strictly, of course, the individualism at the basis of modern industrial society did not begin with the Reformation. It is largely an inheritance from Stoicism. Perfection of character and superiority to social turmoil was the aim of the Stoic. But this, in its truest meaning, was too high for the Stoic to attain. He sought it in self-renunciation, by withdrawal from social duties, not by absorption in them. His perfection came apart from them, and not through their noble discharge. This was really a refined intellectual selfishness, the influence of which waned only before that of Christianity and its purer altruism. But it did not entirely disappear. It received a new emphasis from the Reformation. The result was a breaking up of class dependence. Through its influence on the doctrine of Natural Liberty, this reassertion of the importance of the individual revolutionized the political side of society, finding its expression here in the American and the French Revolutions.

Religious and political freedom thus secured, the next great change was industrial. Industrial progress has been the main line of advance in the last half century, and it has run beyond the limits of harmonious adjustment with the legal and ethical conceptions that were developed before it. Hence it is that there is a shock, or a series of shocks, in the social body. This is but the jarring that arises from its efforts to adjust itself harmoniously to its new environment. Harmony is to be restored only when the same relative degree of progress is attained by all departments of society. For the functions of the organs of the social body are interdependent, and their healthy action goes on only when they are tuned, so to speak, to the same pitch. Otherwise "beats" are inevitable. Accordingly, most of the social and industrial evils at present experienced are due to the fact that industrial development has outrun the juridical, the social, and the practical ethical arrangements of society. "The source of present complaint is found in the fact that the conception of the rights and duties, of liberties and constraints, of privileges and responsibilities, which lies at the basis of our juridical system, is not applied to the highly developed industrial system of the present. Difficulties have arisen because the industrial life and activity of the social organism have grown to a different plane from the one which underlies the juridical system." * The rapidity of the industrial change and the emphasis of the social side of production have so changed the relations between employers and employed that old ideas of justice between the classes have been upset.

The great structure of society rises little by little, now this corner, now that, until at length harmony of level is attained, or rather approximated. For no organ of society can be regarded as strictly quiescent while others are growing up to it. At no period of history, certainly not of the history of the progressive races, has such a period of rest, or quietude, or social harmony, ever been attained. Social forces are never at rest, never at a quiet level, never in stable equilibrium. No sooner has the restoration of the disturbed equilibrium been secured, than the social life reaches out further in some line of its activity, and the series of jars and shocks and readjustments begins anew.

Considerations like the the foregoing make *a priori* schemes of social reform justly open to suspicion, and furnish safe, even though rough, data of the mode in which progress should be made. They enable us to gauge approximately the claims to consideration of many plans now presented. We can endorse

* Science Economic Discussions, page 88.

only those which are comformable both to the direction and stage of a nation's development, and to the character and education of its people; those which may be fitted gradually to existing circumstances, and conform to the laws of social evolution. All that man can do to bring about a new regime, is to change social and economic environment, and not to devise schemes that run counter to social and economic laws.

Viewed in the light of these truths the plans of the socialists, despite their apparent spread, do not bear much promise of ultimate success. Altogether aside from the economic fallacies involved in their proposals, it is clear that they offer a scheme that is impracticable because artificial and unevolutionary.

The scheme of the socialist is not in the line of our historical development. For our tendency has been, and is, towards eliciting the most richly diversified individualism by assuring to each the rewards of his own exertions. But even if Socialism or Nationalism were in the line of our historical development, we have not arrived at the proper stage for its introduction; for it presupposes a state of ethical culture far beyond what we have reached. Nor is the scheme of the socialist in keeping with our national character; for, as already pointed out, we are too tenacious of our personal rights. It is possible, of course, for national character to be changed. But the process must be a slow one, and it can hardly be claimed that ours is changing in a socialistic direction.

The socialists look with satisfaction on the present tendency towards great aggregations of capital in trusts and pools, regarding this as a step towards the realization of their ideals. But this is not a socialistic evolution. It is an intensification of the principal of individualism in industry, an emphasis of its despotic nature. Great combinations of capital are successful only because management and responsibility are concentrated, not diffused. If it could be shown that as pools and trusts are formed, responsibility for their management is divided among the units composing them, this would prove the possibility of general democracy in industry, and be favorable to Socialism. The truth is that Socialism underrates the difficulty of business enterprise.

Socialists also mistake the present social need. Their cry is for a new industrial organization. But, as already pointed out, our present industrial system is the latest and most advanced development of the social organism. It has outstripped other social organs in the race of progress. This is the true explanation of the present disturbance. But we cannot properly call the industrial change the *cause*. It is a symptom. It is at once the result and the sign of progress. Therefore, to attempt a reorganization or a reform of the industrial system, would be to begin at the wrong end. It is not a proper statement of the situation, from the historical and sociological point of view, to say that our present industrial system involves great evils and therefore needs to be changed; but rather, that in the long struggle of social progress, the ethical and juridical functions of the social organism have not yet developed to the extent of the industrial.

This is not to deny that there are evils in the present system of industry. It is to deny that these evils inhere wholly, or mainly, in the system. It is to claim that under different ethical conditions, the evils could be made largely to disappear. Nor is this position a denial of the possibility and desirability of a better system, even under other present conditions. "Whilst, however, an organization of the industrial world may with certainty be expected to arise in process of time, it would be a great error to attempt to improvise one."* Moreover, the establishment of a system perfect from the industrial standpoint alone, would by no means do away with social ills. To draw the industrial system away from the other departments of social life to a still higher plane, would simply increase the strain on the bonds that hold society together. The over-development of one organ to the neglect of others can never produce either a normal man or a normal society.

The fact is that it is in the elevation of practical ethics that we must look for the remedy of most of our present social ills. The industrial evils are not a first cause. They are themselves the result of relatively slow moral and legal progress. And it is to the acceleration of this progress that we must give our

* Ingram's Hist. Pol. Econ., p. 244.

best efforts. We need a higher practical morality, a higher conception of social duty, and juridical conceptions and definitions more in accord with modern conditions. "Our ruling powers have still an equivocal character; they are not in real harmony with industrial life, and are in all respects imperfectly imbued with the modern spirit. What is now most urgent is not legislative interference on any large scale with the industrial relations, but the formation in both the higher and lower regions of the industrial world, of profound convictions as to social duties, and some more effective mode than at present exists of diffusing, maintaining, and applying those convictions."*

Moral force is not, indeed, new in the field of economics. It is an old agent. The increasing extent of its field of operations is new, however. The growing complexity of economic relations has been accompanied by an increasing amount of moral force in actual operation, but not an amount increasing in proportion to the growing needs of the new conditions.

The growing tendency to seek state intervention is an attempt to supply the lack of this moral force. But the attempt confuses the sphere of church and state. It implies a belief that the faults of human character cannot be eradicated, and so must be continuously checked, repressed, crushed, by external authority. The trouble with the method is that the controlling authority itself has the same faults as have its subjects, and that the faults cannot be so held in check. This method does not remedy defects of human character; nor does it do away with temptations to their activity; it only seeks to surround them with legal and conventional barriers. It is true, indeed, that change of industrial environment may have an elevating effect on morals. Amidst the wrecks of profit-sharing and co-operative schemes, for example, there are some that testify to the evolution, as a result of the industrial change, of higher ethical conceptions among those engaged in them. But such means are partial and transitory. A highly moral organization is impossible if the elements composing it are not themselves moral. As Spencer says, "The belief that faulty

* Ingram, *Ibid.*

character can so organize itself socially as to get out of itself a conduct which is not proportionately faulty, is an utterly baseless belief."*

It is not in political, legal, or industrial conditions, then, that we must seek the ultimate change. We do need a new distribution of work as between the state and private individuals, in some particulars, and we need a purification of our political life, an uplifting of our political morality. But that new distribution and that purification will be results, not causes, of a better moral life. We do need a better adaptation of our juridical, or legal, system, to modern industrial conditions. But that adaptation will come only as a result of a perception of the essential injustice of the present system. And that perception, too, will be the result of the nobler altruism of a better moral life. In short, any social reform can be permanent only as it develops individual character, and it is toward the improvement of this that our main efforts must be directed in the future as in the past.

True, in the long meanwhile that must elapse before the harmonious adjustment of the various departments of social life to the highest ethical standard can be attained, our duty is imperative to seek by every legitimate though temporary means, to lessen the jarring, the injustice, the suffering that the existing ill-adjustment produces. To erect barriers against injustice until we can remove its cause and prevent its recurrence; to repress evil until the conditions of life come to be such as of themselves to reduce it to its uneliminable minimum; to change, even arbitrarily if necessary, existing juridical misconceptions and defects, until the environment of essential justice on which the system is founded shall have had time to evolve a "fitter" structure; to remedy, here and there, faults of the existing industrial system at the same time that we work to evolve an entirely new and better one; in short, to treat the social body directly for its specific ills even while we seek to bring it as a whole to a state of good health: these are duties incumbent on the social reformer and the philanthropist in the present, none the less because he is at the same time working

* Study of Sociology, p. 22.

for the evolution of a system which by its nature will render such evils impossible, if, indeed, such a system can be found. But it will be only when perfect justice and love between man and man become spontaneous that there can come the "reformation for which the civilized world groans and travails," and which will not be an isolated fact, but a revolution that will affect every department of society, modifying our whole socia life, and elevating the whole plane of human conduct.

A SUPPLEMENTARY LIST OF PARASITIC FUNGI OF WISCONSIN.

BY J. J. DAVIS, RACINE, WIS.

In the Transactions of the Wisconsin Academy of Science Arts and Letters, Vol. VI., there was published A Preliminary List of the Parasitic Fungi of Wisconsin, by Wm. Trelease, Sc. D. It was presented to the Academy in December, 1882. Since that time considerable additional material has been collected which, it would seem, ought to be used for the extension of the list.

To this end, Prof. Trelease has kindly contributed notes and specimens, Prof. A. B. Seymour of Cambridge, Mass., sent me his Wisconsin collections, other collectors have aided me with notes and specimens and my own collection has been used. Owing to lack of time, Prof. Seymour has been unable to work up his Wisconsin specimens and they were largely undetermined. I have identified as many of them as I was able to, but a considerable number remain until he shall find time to name them. Of course these lists do not approach a complete enumeration of the Parasitic Fungi of Wisconsin, and it is to be hoped that those who collect within the limits of the state will work towards the completion of the undertaking so well begun by Professor Trelease. The name of the collector is given in all cases except when the specimens were collected by me and are preserved in my herbarium.

The notes on distribution and quantity refer to the vicinity of Racine, and are jotted down from recollections of field experience, which, as every collector knows, varies much from year to year. The words common and rare are used with reference to distribution, abundant and scarce with reference to quantity.

In addition to Profs. Trelease and Seymour, I desire to express my obligations to Mr. E. W. D. Holway of Decorah,

Iowa, for invaluable assistance in various ways; To Mr. J. B. Ellis of Newfield, N. J., who has determined a large proportion of the specimens upon which the list is based, and to Prof. Chas. H. Peck of Albany, N. Y., and Prof. W. G. Farlow, of Cambridge, Mass., who have kindly examined specimens sent them.

RACINE, Wisconsin, February, 1893.

ADDITIONAL HOSTS AND NOTES.

It happens that botanists separated by space, time or language, unwittingly describe the same thing, each under a different name. To reduce the confusion caused thereby it is necessary to have a general rule to be applied in all such cases. The rule which has been adopted for that purpose is that the name first published shall be taken. The white rusts have been universally known by the generic name *Cystopus*. It is found however, that the name *Albugo* had been previously used in that connection. It seems to me that in such a case the "law of priority" should not operate because the exigency it was designed to meet did not exist. The generic name *Albugo* having been revived, however, it seems necessary to adopt it to obviate the confusion due to its resuscitation. It appears to me that in the strict application of the "law of priority" the means are sometimes unduly exalted above the end. Our white rusts then would stand as follows: *

4. ALBUGO CANDIDUS, (Pers.) O. Kuntze. (*Cystopus candidus*, P., Prelim. List.) Also on *Cakile Americana*, Nutt. Racine.

5. ALBUGO TRAGOPOGONIS, (Pers.) S. F. Gray. (*Cystopus cubicus*, (Strauss) Lev., Prelim. List.)

This was rather abundant on *Cnicus arvensis*, Hoffm., in waste ground on the outskirts of the city of Racine in 1886. I have not seen it on this host since.

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* The numbers attached are those under which they were enumerated in the Preliminary List.

6. Albugo amaranthi, (Schw.) O. Kuntze. (*Cystopus bliti*, Biv.-Prelim. List.)

On *Acnida tuberculata*, Moq. Racine.

Since the Preliminary List was written the genus *Peronospora* has been divided, which changes the designation of some of the species therein enumerated.

9. Plasmopara viticola, (B. & C.) Berl. and DeToni. (*Peronospora*, Prelim. List.)

10. Plasmopara halstedii, (Farl.) Berl. and DeToni. (*Peronospora*, Prelim. List.) Also on *Bidens chrysanthemoides*, Michx. Racine.

11. Plasmopara obducens, Schroeter. (*Peronospora*, Prelim. List.)

12. Plasmopara geranii, (Pk.) Berl. and DeToni. (*Peronospora*, Prelim. List.)

13. Plasmopara entospora, (Roze and Cornu) Berl. and DeToni. (*Peronospora*, Prelim. List.)

On *Aster sagittifolius*, Willd. Racine.

14. Plasmopara pygmæa, (Ung.) Schroet. (*Peronospora*, Prelim. List.)

On *Hepatica acutiloba*, DC. Racine.

15. Bremia lactucæ, Regel (*Peronospora gangliformis*, (Berk.) Prelim. List.)

16. Peronospora parasitica, (Pers.) Tul.

On *Dentaria laciniata*, Muhl, and *Cardamine rhomboidea*, DC., Racine.

17. Peronospora potentillæ, D By.

On *Geum album*, Gmel. and *Agrimonia Eupatoria*, L., Racine. Common and abundant on the former host. Not seen on Agrimonia until 1892, when it was rather abundant in one station, though less so on *Geum* than in previous years.

21. Peronospora alta, Fckl.

On *Plantago Rugelii*, Dcsne., Racine.

25. PLASMOPARA AUSTRALIS, (Speg.) Swingle. (*Peronospora*, Prelim. List.)

28. SCLEROSPORA GRAMINICOLA, (Sacc.) Schroet. (*Peronospora*, Prelim. List.)

The changes made in the list of *Erysipheæ* are to bring it into conformity with the monograph of the North American species of the family, by Prof. T. J. Burrill in NORTH AMERICAN PYRENOMYCETES.

31. UNCINULA SALICIS, (DC.) Winter. (*N. adunca*, (Wallr.) Prelim List.)

On *Populus tremuloides*, Michx. Racine. On *P. tremuloides*, Michx., and *P. angulata*, Ait. (Tracy and Galloway in Journal of Mycology, IV.—35.

32 and 33. UNCINULA NECATOR, (Schw.) Burrill. (*U. subfusca*, B. & C., and *U. Americana*, Howe, Prelim. List.)

On *Vitis cordifolia*, Michx. Racine.

34. UNCINULA CIRCINATA. C. & P.

On *Acer saccharinum*, Wang. Racine.

37. MICROSPHÆRA DIFFUSA, C. & P.

The fungus on *Lathyrus ochroleucus*, Hook. referred here in the Prelim. List would now probably be placed in *Microsphæra ravenelii*, Berk.

36, 38, 40. MICROSPHÆRA ALNI, (DC.) Winter. (*Microsphæra friesii*, Lev., *M. pulchra*, C. & P., and *M penicillata*, (Wall.) Prelim. List.

These species, with others, are united by Burrill under the above name.

On *Ilex verticillata*, Gray, *Viburnum dentatum*, L., *Betula pumila*, L., *Carpinus Caroliniana*, Walter, and *Fagus ferruginea*, *Ait.* Racine.

39. MICROSPHÆRA GROSSULARIÆ, (Wallr.) Lev. (*Microsphæra Van Bruntiana*, Ger. Prelim. List.)

41. MICROSPHÆRA QUERCINA, (Schw.) Burrill. (*Microsphæra extensa*, C. & P., Prelim. List.)

On *Quercus alba*, L., *Quercus macrocarpa*, Michx. and *Quercus palustris*, Du Roi. Racine.

43. PODOSPHÆRA OXYACANTHÆ, (DC.) D By. (*Podosphæra tridactyla*, Wall., Prelim. List.)

On *Cratægus tomentosa*. L. and *Pyrus coronaria*, L. Racine. *Cratægus Oxyacantha*, L. (Tracy and Galloway, *loc. cit.* p. 34.) Rather common on the wild crab leaves in 1888, but the perithecia were much scattered.

44. PHYLLACTINIA SUFFULTA, (Reb.) Sacc.

On *Alnus incana*, Willd., *Acer saccharinum*, Wang., *Hamamelis Virginiana*, L., *Fagus ferruginea*, Ait., *Ostrya Virginica*, Willd., *Xanthoxylum Americanum*, Mill., *Betula papyrifera*, Marsh. *Cornus stolonifera*, *Michx.* and *Carya* sp. Racine.

45. SPHÆROTHECA CASTAGNEI, Lev.

On *Lactuca Floridana*, Gaert., *Prenanthes alba*, L., and *Pedicularis lanceolata*, Michx. Racine.

The mildews on *Rubus triflorus*, Rich., and *Agrimonia Eupatoria*, L., referred to this species in the Preliminary List would now probably be placed in *Sphærotheca humuli*, (DC.) Burrill.

47. The *Erysiphe* on *Clematis* is referred to *Erysiphe communis* (Wallr.) Fr. (*Erysiphe tortilis*, Wall. Prelim. List.)

48. ERYSIPHE CICHORACEARUM, DC. (*Erysiphe lamprocarpa*, (Wall.) Prelim. List.)

On *Aster puniceus*, L., *Aster sagittifolius*, Willd., *Solidago Canadensis*, L., *Helenium autumnale*, L., *Aster corymbosus*, Ait., *Ambrosia trifida*, L., and *Phlox divaricata*, L. Racine. *Aster corymbosus*, Ait., and *Inula Helenium*, L. (Tracy and Galloway, *loc. cit.*)

49. ERYSIPHE COMMUNIS, (Wallr.) Fr.
On *Astragalus Canadensis*, L., *Aquilegia Canadensis*, L., and *Geranium maculatum*, L. (Tracy and Galloway, *loc. cit.*) *Thalictrum purpurascens*, L. Racine. As noted above (No. 47) *Clematis Virginiana*, L., should probably be added as a host of this species in Wisconsin.

67. CLAVICEPS, sp.
Sclerotia also on *Juncus nodosus*, L., and *Glyceria fluitans*, R. Br. Racine.

69. HYPOCRELLA, sp.

Dr. Trelease writes that this is directly parasitic on the leaves.

77. MICROSTROMA LEUCOSPORUM, Mont. "Represented" on *Juglans cinerea*, L., "from just across the line in Minnesota and Illinois, and hence certain to be found in Wisconsin. It should also occur on *Carya.*" (Prelim. List.)

It occurs at Racine on both *Juglans* and *Carya*, and at Lake Geneva on *Juglans cinerea*, L. The form on *Juglans* has been separated as *Microstroma juglandis*, (Bereng.) Sacc.

78. RAMULARIA DIDYMA, Ung.
On *Ranunculus repens*, L. (?) Racine. So labelled before *R. septentrionalis*, Poir., was differentiated and is likely the latter.

80. RAMULARIA PLANTAGINIS, E. and Martin.
On *Plantago Rugelii*, Dcsne. Racine.

82. RAMULARIA ARVENSIS, Sacc.
On *Potentilla Anserina*, L. Bassett.

83. RAMULARIA MACROSPORA, Fres. var. ASTERIS, Sacc. (Var. *senecionis*, Sacc. Prelim. List.)

Dr. Trelease states that the varietal name should be as given above. Occurs also at Racine on the same host.

89. RAMULARIA DESMODII, Cke.
On *Lespedeza*, sp. Racine.

91. CERCOSPORELLA CANA, (Pass.) Sacc.
On *Erigeron anuuus*, Pers. Racine.

95. CERCOSPORA CHENOPODII, Fres.
On *Atriplex patulum*, L. Racine.

107. COLLETOTRICHUM LAGENARIUM, (Pass.) E. & Hals.
(*Glœosporium lindemuthianum*. Sacc. & Magnus, Prelim. List.) On watermelon rinds. Madison (Trelease & Seymour).

117. "PHYLLOSTICTA TRELEASII, Berl. & Vogl. in Sacc. Sylloge, Suppl. I–15, but scarcely distinct from *P. serotina*." (Trelease.)

118. ASCOCHYTA TRELEASII, Berl. & Vogl. *loc cit.* 332. (Trelease.)

126. SEPTORIA DENTARIÆ, Peck. (*Septoria sisymbrii*, Ellis., Prelim. List.)
On *Cardamine rhomboidea*, DC. Racine.

129. SEPTORIA VIOLÆ, West.
On *Viola palmata*, L., var. *cucullata*, Gray. Genoa Junction.

137. The spore measurements given in the Preliminary List correspond with those of *Septoria aquilegiæ*, E. & K., to which it is probable Mr. Pammel's specimens should be referred. It has also been collected in Kenosha county on the same host.

139. This is *Septoria divaricata*, E. & E., doubtless which also occurs at Racine on the same host.

141. SEPTORIA RUBI, West.
On *Rubus villosus*, Ait. Racine.

143. SEPTORIA SILPHII, E. & E.

Dr. Trelease informs me that the specimens described under this number should be placed as above. I have collected it at Clinton Junction on *Silphium perfoliatum*, L.

144. RHABDOSPORA RIBICOLA, (B. & C.) Sacc. (*Septoria ribicola*, B. & C. Prelim. List.)

150. UROMYCES FABÆ, (Pers.) DBy. (*U. orobi*, (Pers.) Prelim. List.)
Uredo on *Vicia Americana*, Muhl. Berryville.

154. UROMYCES JUNCI, (Desm.) Tul.
On *Juncus tenuis*, Willd. Racine.

158. UROMYCES HYPERICI, (Schw.) Curtis.
Uredo and teleutospores as well as æcidia on *Elodes campanulata*, Pursh. Genoa Junction. Uredo and teleutospores on *Hypericum maculatum*, Walter. Racine.

159. UROMYCES RUDBECKIÆ, Arthur & Holway. Iowa Uredineæ, 154. (Trelease.) (*U. solidaginis*, (Niessl.) Prelim. List.)

167. PUCCINIA SILPHII, Schw.
Teleutospores on *Silphium laciniatum*, L. Racine county.

170. Lagerheim refers this to the genus *Rostrupia*.

171. PUCCINIA BARYI, (B. & Br.) Winter.
On *Calamagrostis Canadensis*, Beauv. Racine.

172. PUCCINIA ANDROPOGI, Schw.
Teleutospores on *Andropogon furcatus*, Muhl. Racine.

190. PUCCINIA GALII, (Pers.) Winter.
Teleutospores on *Galium concinnum*, Torr. & Gr. Racine.

191. PUCCINIA PIMPINELLÆ, (Strauss.) Lk.
Æcidium, uredo and teleutospores on *Osmorrhiza longistylis*, DC. Racine.

192. PUCCINIA MENTHÆ, Pers.
Acidium on *Mentha Canadensis*, L. Teleutospores on *Hedeoma pulegioides*, Pers. Racine.

198. PUCCINIA VIOLÆ, (Schum.) DC.
Æcidium, uredo and teleutospores on *Viola canina*, L., var. *Muhlenbergii*, Gray. Racine.

199. PUCCINIA RUBIGO-VERA, (DC.) Winter.

Uredo and teleutospores on *Eatonia Pennsylvanica*, Gray. Teleutospores on *Bromus ciliatus*, L., *Asprella Hystrix*, Willd., and *Elymus Virginicus*, L. Racine.

A uredo which is sometimes very abundant on *Poa*, perhaps belongs here. Racine, Madison. (Seymour.)

200. PUCCINIA GRAMINIS, Pers.

Teleutospores on *Alopecurus geniculatus*, L., var. *aristulatus*, Gray. Racine.

201. See *Æcidium rhamni*, Gmel., No. 485.

204. PHRAGMIDIUM SPECIOSUM, Fr.

On *Rosa blanda*, Ait. Sauk. (Lueders *fide* Trelease.)

205. PHRAGMIDIUM RUBI-IDÆI, (Pers.) Wint.

Uredo and teleutospores on *Rubus strigosus*, Michx. Racine.

225. ÆCIDIUM MARIÆ-WILSONI, Peck. (*Æ. Petersii*, B. & C., Prelim. List.)

"The name above given has priority."—Trelease.

227. ÆCIDIUM GROSSULARIÆ, DC.

On *Ribes oxyacanthoides*, L. Racine.

231. ÆCIDIUM CONVALLARIÆ, Schum.

On *Smilacina*. Sharon.

235. ÆCIDIUM THALICTRI, Grev.

On *Thalictrum purpurascens*, L. Racine.

237. Dr. Trelease writes that this is *Æcidium hepaticatum*, Schw., in part.

242. ÆCIDIUM COMPOSITARUM, Mart.

On *Polymnia Canadensis*, L., *Rudbeckia laciniata*, L., *Silphium integrifolium*, Michx., *Silphium terebinthinaceum*, L. Racine. *Bidens frondosa*, L., *Xanthium strumarium*, L. Kansasville. *Enpatorium purpureum*, L. Walworth county.

243. Probably the æcidium of *Gymnosporangium globosum*, Farlow. (No. 208.)

244. This I presume is now to be referred to *Roestelia pyrata*, (Schw.) Thaxter, the æcidium of *Gymnosporangium macropus*, Link. No. 207.

253. "Probably a form of No. 250."—Trelease.

256. ENTYLOMA COMPOSITARUM, Farlow.

On *Senecio aureus*, L., and *Ambrosia trifida*, L. Racine.

258. ENTYLOMA LINEATA (Cke.) (*E. crastophilum*, Sacc. (?) Prelim. List.) Specimens collected at Kansasville on *Zizania aquatica*, L. are referred to this species by Dietel and Ellis. I assume that Dr. Trelease's specimens are the same.

263. Prof. Farlow states that this is not *Entyloma thalictri*, Schroeter. It has been collected at Racine on *Anemone nemorosa*, L.

265. UROCYSTIS ANEMONES, Pers.

On *Hepatica acutiloba*, DC. Racine.

249. The smuts referred to *Ustilago segetum*, Persoon, have been divided. That on *Triticum vulgare*, Vill., as *U. tritici*, (Pers.) Jensen, on *Avena sativa*, L., as *U. avenæ*, (Pers.) Jensen, while two species have been recognized on *Hordenm vulgare*, L., viz: *U. hordei*, (Pers.) Kellerman and Swingle, and *U. nuda*, (Jensen) Kellerman and Swingle. Both of the latter probably occur in Wisconsin. Kellerman and Swingle refer to a specimen of *U. nuda* collected at LaCrosse by Prof. Pammel. (Second Annual Report of the Experiment Station, Kansas.)

ADDITIONAL SPECIES.

NOT RECORDED IN THE PRELIMINARY LIST.

CHYTRIDIACEÆ.

269. SYNCHYTRIUM AUREUM, Schroeter.
On *Viola pubescens*, Ait., and *Geum album*, Gmel. Berryville. Not scarce.

270. SYNCHYTRIUM PLURIANNULATUM, (B. & C.) Farlow.
On *Sanicula Marylandica*, L. Berryville and Racine. Not scarce.

PERONOSPORACEÆ.

271. PERONOSPORA EUPHORBIÆ, Fckl.
On *Euphorbia maculata*, L. Madison. (Seymour.)

272. PERONOSPORA FICARIÆ, Tul.
On *Ranunculus fascicularis*, Muhl. Madison. (Seymour.) On *Ranunculus recurvatus*, Poir. Racine. Rare.

273. PERONOSPORA SORDIDA, B. & Br.
On *Scrophularia nodosa*, L., var. *Marylandica*, Gray. Racine. Only observed in 1892 and in a single station, where it was rather abundant.

GYMNOASCI.

274. TAPHRINA DEFORMANS, (Berk.) Tul.
On *Prunus Virginiana*, L. Genoa Junction. Collected but once.

275. TAPHRINA RHIZOPHORA, Johans.
On fruit of *Populus tremuloides*, Mx. Racine. abundant.

ERYSIPHEÆ.

276. ERYSIPHE GALEOPSIDIS, DC.

On *Scutellaria lateriflora*, L. Racine. On *Scutellaria parvula*, Michx. "Wisconsin." (Tracy & Galloway, Journal of Mycology, IV–34.)

277. MICROSPHÆRA RAVENELII, Berk.

On *Lathyrus ochroleucus*, Hook, and *L. venosus*, Muhl. Racine. The specimens on the former host, referred to *Microsphæra diffusa*, C. & P., in the Preliminary List, would probably be placed here by Prof. Burrill. (Bulletin of the Illinois State Laboratory of Natural History, II–420.)

278. MICROSPHÆRA SEMITOSTA, B. & C.

On *Cephalanthus occidentalis*, L. Eagle Lake, Racine county. Rare. Perithecia sparsely formed.

279. MICROSPHÆRA VACCINII, C. & P.

On *Gaylussacia resinosa*, Torr. & Gray. Berryville. Neither common nor abundant.

280. SPHÆROTHECA EPILOBII, (Lk.) DBy.

On *Epilobium coloratum*, Muhl. Racine.

281. SPHÆROTHECA HUMULI, (DC.) Burrill.

On *Geum album*, Gmel., *Geum Virginianum*, L., and *Agrimonia Eupatoria*, L. Racine. *Potentilla palustris*, Scop. Kansasville. On *Geum macrophyllum*, Willd. "Wisconsin." (Tracy & Galloway, Journal of Mycology, IV–34.) Probably the specimens on *Agrimonia Eupatoria*, L., and those on *Rubus triflorus*, Rich., would now be placed here. (Prelim. List. No. 45.) Common and abundant.

282. SPHÆROTHECA MORS-UVÆ, (Schw.) B. & C.

On *Ribes floridum*, L. Racine. The mycelium is abundant on species of Ribes, but the perithecia are not common and the only specimen in my herbarium is on the above host.

283. Uncinula clintonii, Peck.
On *Tilia Americana*, L. Racine. Neither rare nor scarce.

284. Uncinula macrospora, Peck.
On *Ulmus Americana*, L. Racine. Not common.

Perisporiaceæ.

285. Asterina gaultheriæ, Curtis.
On *Gaultheria procumbens*, L. Three Lakes. Abundant.

286. Asterina rubicola, E. & E.
On *Rubus strigosus*, Michx. Racine. Sometimes abundant.

287. Capnodium salicinum, Mont.
The conidial stage, *Fumago vagans*, Pers., on *Salix*. Racine.

288. Dimerosporium pulchrum, Sacc.
The conidial stage, *Sarcinella heterospora*, Sacc., on *Cornus paniculata*, L'Her, and *C. stolonifera*, Michx. Racine. Not rare.

289. Læstadia bidwellii, (Ellis) Viala & Ravaz.
The pycnidia, *Phyllosticta labruscæ*, Thum., on *Vitis cordifolia*, Michx. Racine.

Phacidiaceæ.

290. Pseudopeziza repanda, (Fr.) Karst. (*Phacidium autumnale*, Fckl.)
On *Galium trifidum*, L. Racine. Not rare.

291. Rhytisma acerinum, Fr.
On *Acer saccharinum*, Wang., and very abundant on *Acer dasycarpum*, Ehrh., grown along the roadsides near Racine. Specimens kept exposed to the weather matured in June.

Fungi Imperfecti.

Isolated Imperfect Forms.

292. Ascochyta cornicola, Sacc.
On *Cornus sericea*, L. Madison. (Seymour.) Racine.

293. Ascochyta pisi, Lib.
On pea pods from the Racine market.

294. Ascochyta silenes, E. & E.
On *Silene antirrhina*, L. Eagle Lake, Racine county.

295. Asteroma venulosum, (Wallr.)
On *Iris versicolor*, L. Racine. Common.

296. Cercospora althæina, Sacc.
On *Althœa rosea*, L. Madison. (Seymour.) Racine. Abundant.

297. Cercospora ampelopsidis, Peck.
On *Ampelopsis quinquefolia*, Michx. Madison. (Seymour.)

298. Cercospora antipus, Ell. & Holw.
On *Lonicera*, sp. Eagle Lake, Racine county. *Lonicera Sullivantii*, Racine.

299. Cercospora clavata, Gerard.
On *Asclepias Cornuti*, Dcsne. Madison. (Seymour.) On *Asclepias Cornuti*, Dcsne., and *A. incarnata*, L. Racine. *Asclepias phytolaccoides*, Pursh. Walworth county. Common and abundant.

300. Cercospora davisii, E. & E.
On *Melilotus alba*, Lam. Racine. Not common.

301. Cercospora galii, Ell. & Holway.
On *Galium triflorum*, Michx. Racine. Rare.

302. Cercospora heucheræ, E. & M.
On *Heuchera*. Genoa Junction.

303. Cercospora microsora, Sacc.
On *Tilia Americana*, L. Genoa Junction.

303*a*. Cercospora monoica, E. & Holway.
On *Amphicarpœa monoica*, Nutt. Racine.

304. Cercospora montana, Speg.
On *Epilobium coloratum*, Muhl. *Cercospora epilobii*, Schn., is perhaps a more mature state, having 2—3 septate spores. In the Racine specimens the spores are uni-septate.

305. Cercospora omphakodes, Ell. & Holway.
On *Phlox divaricata*, L. Racine.

306. Cercospora osmorrhizæ, E. & E.
On *Osmorrhiza longistylis*, DC. Racine. Rare.

307. Cercospora pentstemonis, E. & K.
On *Pentstemon pubescens*, Solander. Kansasville. Rare.

308. Cercospora perfoliata, E. & E.
On *Eupatorium perfoliatum*, L., and *Eupatorium purpureum*, L. Racine. Not common.

309. Cercospora (Cercosporella) pirina, E. & E.
On *Pyrus coronaria*, L. Racine. Rare but sometimes rather abundant.

310. Cercospora platyspora, Ell. & Hol.
On *Pimpinella integerrima*, B. & H. Madison. (Seymour.) Racine. Abundant.

311. Cercospora polygonorum, Cke.
On *Polygonum*. Madison. (Seymour.) On *Polygonum Hydropiper*, L. Racine.

312. Cercospora punctoidea, E. & Hol.
On *Galium trifidum*, Ait. Racine. Not common.

313. Cercospora reticulata, Peck.
On *Solidago serotina*, Ait. Racine. Rare.

314. Cercospora sagittariæ, Ell. & Kell.
On *Sagittaria variabilis*, Engelm. Racine.

315. Cercospora sequoiæ, E. & E., var. Juniperi, E. & E.
On *Juniperus Virginiana*, L. Genoa Junction. Rare.

316. Cercospora sii, E. & E.
On *Sium cicutæfolium*, Gmel. Racine.

317. Cercospora squalidula, Peck.
On *Clematis Virginiana*, L. Racine.

318. Cercospora tuberosa, Ell. & Kell.
On *Apios tuberosa*, Moench. Racine. Abundant.

319. Cercospora varia, Peck.
On *Viburnum Lentago*, L. Racine.

320. Cercospora vernoniæ, E. & Kell.
On *Vernonia fasciculata*, Michx. Racine. Rare.

321. Cercospora ziziæ, E. & E.
On *Zizea aurea*, Koch. Racine.

322. Cylindrosporium apocyni, E. & E.
On *Apocynum androsœmifolium*, L. Racine. Common.

323. Cylindrosporium cicutæ, E. & E.
On stems of *Cicuta maculata*, L. Kansasville.

324. Cylindrosporium humuli, E. & E.
On *Humulus Lupulus*, L. Racine. Abundant.

325. Cylindrosporium rubi, Ellis & Morgan.
On *Rubus strigosus*, cultivated. "Wisconsin, Dr. J. Brown." (Journal of Mycology, I-127.)

326. Cylindrosporium saccharinum, E. & E.
On *Acer saccharinum*, Wang. Racine.

327. Cylindrosporium ziziæ, E. & E.
On *Zizia cordata*, DC. Racine.

328. Entomosporium maculatum, Lev.
On *Amelanchier Canadensis*, Torr. & Gr. Racine. Rare.

329. Entomosporium thumenii, (Cke.) Sacc.
On *Cratœgus punctata*, Jacq., and other species. Common and abundant.

330. Fusarium uredinum, E. & E.
On *Salix nigra*, Marsh. Racine. Abundant. This was suspected of being parasitic on the summer form of *Melampsora salicina*, Lev., but further observation showed that the willow was the host.

331. FUSICLADIUM ANGELICÆ, E. & E.
On *Angelica atropurpurea*, L. Racine.

332. GLŒOSPORIUM AMPELOPSIDIS, E. & E.
On *Ampelopsis quinquefolia*, Michx. Racine.

333. GLŒOSPORIUM (MARSONIA) APICALIS, E. & E.
On *Salix lucida*, Muhl. Racine. Scarce.

334. GLŒOSPORIUM APOCRYPTUM, E. & E.
On *Negundo aceroides*, Moench. This species is very common on the Box Elders cultivated for shade trees in the city of Racine. In favorable seasons it nearly defoliates them.

335. GLŒOSPORIUM ARIDUM, E. & E.
On *Fraxinus Americana*, L. Racine. Abundant. When developing vigorously on exposed trees it attacks one edge of the leaf, causing it to curl toward the affected side. When less vigorous on leaves of shaded trees it occurs on roundish spots about 5 mm. in diameter.

336. GLŒOSPORIUM BERBERIDIS, Cke.
On *Berberis vulgaris*, L. Racine.

337. GLŒOSPORIUM CANADENSE, E. & E.
On *Quercus alba*, Racine and Kenosha county. On *Quercus macrocarpa*, Michx. Racine. This fungus is very destructive to the leaves of the white oaks some seasons.

338. GLŒOSPORIUM CORYLI, (Desm.) Sacc.
On *Corylus Americana*, Walt. Racine. Not uncommon.

339. GLŒOSPORIUM FAGI, Desm. & Rob., var. AMERICANUM, E. & E.
On *Fagus ferruginea*, Ait. Racine. Not common.

340. GLŒOSPORIUM FRUCTIGENUM, Berk.
Not uncommon on apples from the Racine market.

341. GLŒOSPORIUM PHEGOPTERIDIS, Frank.
On *Onoclea sensibilis*, L., and *Aspidium Thelypteris*, Swartz. Racine. Sometimes abundant on the first mentioned host. On the Aspidium it does not seem to develop so perfectly.

342. GLŒOSPORIUM PRUNICOLUM, E. & E.
On *Prunus Virginiana*, L. Racine. Abundant, but apparently not common.

343. GLŒOSPORIUM POTENTILLÆ, (Desm.) Oud.
On *Potentilla palustris*, Scop. Kansasville.

344. GLŒOSPORIUM RIBIS, (Lib.) Desm. & Mont.
On *Ribes floridum*, L., and wild and cultivated gooseberries. Racine. Abundant.

345. GLŒOSPORIUM ROBERGEI, Desm.
On *Carpinus Caroliniana*, Walt. Racine.

346. GLŒOSPORIUM SACCHARINUM, E. & E.
On *Acer saccharinum*, Wang. Racine and Waukesha. Destructive to the leaves of city shade trees; sometimes very much so. On forest trees it is much less common and usually confined to definite spots on the leaves.

347. GLŒOSPORIUM AMERICANUM, E. & E.,
On leaves of *Vicia Americana*, Muhl. Berryville.

347*a*. GLŒOSPORIUM DAVISII, E & E.
On pods of *Vicia Americana*, Muhl. Berryville. This and the proceding occur on the same plants and their distinctness may be doubted.

348. GONATOBOTRYS MACULICOLA, Wint.
On *Hamamelis Virginiana*, L. Racine.

349. HETEROSPORIUM ALLII, Ell. & Martin.
On *Allium Canadense*, Kalm. Racine. Rather abundant in the only station where it was observed.

350. ISARIOPSIS PUSILLA, Fres.
On *Cerastium*, sp. Racine and Lake Geneva. Common

351. Leptothyrium dryinum, Sacc.
On *Quercus rubra.* L. Racine.

352. Leptothyrium periclymeni, Desm., var. Americanum, E. & E.
On *Lonicera oblongifolia*, Muhl. Racine county. On *Lonicera*, sp. Three Lakes. The scutellate perithecia are absent from the specimens collected at Wind Lake in Racine county, but the fungus is evidently the same as in specimens from northern Wisconsin and elsewhere in which they are present. In none of the American specimens that I have seen are the perithecia as well developed as in those from Europe.

353. Oidium pirinum, E. & E.
On *Pyrus coronaria*, L. Racine. Rare.

354. Oidium radiosum, Lib.
On *Populus tremuloides*, Michx. Racine.

355. Pestalozziella subsessilis, E. & E.
On *Geranium maculatum*, L. Madison. (Trelease.)

356. Phleospora oxyacanthæ, (Kze. & Schm.)
On *Cratægus*, sp. Racine. Abundant.

357. Phyllosticta astericola, E. & E.
On *Aster umbellatus*, Mill. Kenosha county. Rare.

358. Phyllosticta ampelopsidis, Ell. & Martin.
On *Ampelopsis quinquefolia*, Michx. Kansasville.

359. Phyllosticta cruenta, Fr.
On *Uvularia grandiflora*, Smith. Genoa Junction. On *Smilacina*, sp. Walworth county.

360. Phyllosticta desmodii, E. & E.
On *Desmodium*, sp. Walworth county.

361. Phyllosticta fagicola, Ell. & Morgan.
On *Fagus ferruginea*, Ait. Racine. Scarce.

362. Phyllosticta gentianæcola, Fr.
On *Gentiana Andrewsii*, Griseb. Racine. Abundant.

363. PHYLLOSTICTA HAMAMELIDIS, Cke.
On *Hamamelis Virginiana*, L. Racine. Rather abundant.

364. PHYLLOSTICTA HELIANTHI, E. & E.
On *Helianthus*, sp. Racine county.

Phyllosticta labruscæ, Thum., is given under *Læstadia bidwellii*, Viala & Ravaz, of which it is supposed to be a pycnidial form.

365. PHYLLOSTICTA NEBULOSA, Sacc.
On *Silene noctiflora*, L. Racine. Rare.

366. PHYLLOSTICTA PHOMIFORMIS, Sacc.
On *Quercus alba*, L. Racine.

367. PHYLLOSTICTA PRUNICOLA, Sacc.
On *Prunus serotina*, Ehrh. Racine. Not common.

368. PHYLLOSTICTA PYRINA, Sacc.
On *Pyrus coronaria*, L. Racine.

369. PHYLLOSTICTA SEROTINA, Cke.
On *Prunus serotina*, Ehrh. Racine. Perhaps the same as No. 117 of the Preliminary List.

370. PHYLLOSTICTA TINEOLA, Sacc.
On *Viburnum dentatum*, L. Racine.

371. PIGGOTIA FRAXINI, B. & C.
On *Fraxinus*, sp. Madison. (Seymour.) Racine.

372. RAMULARIA ASTRAGALI, Ell. & Holway.
On *Astragalus Canadensis*, L. Racine. Not common.

373. RAMULARIA BARBAREÆ, Peck.
On *Barbarea vulgaris*, R. Br. Clinton Junction.

374. RAMULARIA BRUNELLÆ, E. & E.
On *Brunella vulgaris*, L. Racine. The spotted leaves are very common and abundant, but the conidial tufts are sparingly developed.

375. RAMULARIA DECIPIENS, E. & E.
On *Rumex obtusifolius*, L. Racine and Sharon.

376. Ramularia desmodii, Cke.
On *Lespedeza*, sp. Racine.

377. Ramularia dioscoreæ, E. & E.
On *Dioscorea villosa*, L. Racine. Not uncommon.

378. Ramularia hamamelidis, Peck.
On *Hamamelis Virginiana*, L. Racine. Rather abundant.

379. Ramularia impatientis, Peck.
On *Impatiens pallida*, Nutt. Madison. (Seymour.) *Impatiens*, sp. Kenosha county.

380. Ramularia lysimachiæ, Thum.
On *Steironema ciliatum*, Raf. Racine. Rare and scarce.

381. Ramularia occidentalis, E. & E.
On *Rumex*, sp. Racine. Not common.

382. Ramularia oxalidis, Farl.
On *Oxalis*. Bayfield. (Holway.)

383. Ramularia prini, Peck.
On *Ilex verticillata*, Gray. Racine. Abundant.

384. Ramularia reticulata, E. & E.
On *Osmorrhiza*, sp. Waterford. Rare and scarce.

385. Ramularia rosea, (Fckl.) Sacc.
On *Salix rostrata*, Richards. Racine. Abundant.

386. Ramularia rudbeckiæ, Peck.
On *Rudbeckia laciniata*, L. Racine. Very common and abundant.

387. Ramularia rufomaculans, Peck.
On *Polygonum aviculare*, L., and *P. Muhlenbergii*, Watson. Racine. On *Polygonum Muhlenbergii*, Watson. Kansasville. A Ramularia which was found growing abundantly on buckwheat (*Fagopyrum esculentum*, Moench.) in Kenosha county appears to belong here, but there is an entire absence of spots.

388. RAMULARIA TARAXACI, Karst.
On *Taraxacum officinale*, Weber. Racine and Sharon. Common.

389. RAMULARIA VARIABILIS, Fckl.
On *Verbascum Thapsus*, L. Racine. Not uncommon.

390. RAMULARIA VERONICÆ, Fckl.
On *Veronica serpyllifolia*, L. Racine. Not on *V. peregrina* as first reported. (Journ. Mycol., IV-1.)

391. RAMULARIA VIBURNI, E. & E.
On *Viburnum Lentago*, L. Racine. Rare and scarce.

392. SCOLECOTRICHUM GRAMINIS, Fckl.
On *Dactylis glomerata*, L. Madison. (Trelease.)
On *Phleum pratense*, L. Racine.

393. SCOLECOTRICHUM MACULICOLA, E. & Kell.
On *Phragmites communis*, Trin. Racine. Rather abundant.

394. SEPTOCYLINDRIUM RANUNCULI, Peck.
On *Ranunculus abortivus*, L. Racine. Rather common.

395. SEPTORIA ÆGOPODII, Desm.
On *Osmorrhiza longistylis*, DC. Racine. Rare.

396. SEPTORIA AGRIMONIÆ, Roum. (?)
On *Agrimonia Eupatoria*, L. Sharon. Spores 22-28x1.5 microns.

397. SEPTORIA AGROPYRI, E. & E.,
On *Agropyrum repens*, Beauv. Racine.

398. SEPTORIA ALBANIENSIS, Thum.
On *Salix lucida*, Muhl. Racine. Common and abundant.

398*a*. SEPTORIA ALBICANS, E. & E.
On *Saxifraga Pennsylvanica*, L. Genoa Junction.

399. SEPTORIA ASCLEPIADICOLA, E. & E.
On *Asclepias incarnata*, L. Racine and Genoa Junction. Common.

400. Septoria astericola, Ell. & Evht.
On *Aster sagittifolius*, Willd. Racine.

401. Septoria atropurpurea, Peck.
Cn *Aster macrophyllus*, L. Racine.

402. Septoria aurea, E. & E.
On *Ribes aureum*, Pursh. (cult.) Racine.

402*a*. Septoria betulæ, (Lib.) West.
On *Betula papyrifera*, Marsh. Three Lakes.

403. Septoria campanulæ, (Lev.) Ellis.
On *Campanula Americana*, L. Madison. (Seymour.) Kenosha county.

404. Septoria canadensis, Ell. & Davis.
On *Solidago Canadensis*, L. Racine and Sharon.

405. Septoria caricinella, Sacc. & Roum.
On *Carex cephaloidea*, Boott and *Carex*, sp. Racine. Not scarce.

406. Septoria cerastii, Rob. & Desm.
On *Cerastium*, sp. Lake Geneva. Racine.

407. Septoria cirsii, Niessl.
On *Cnicus arvensis*, Hoffm. Racine. Rather common and abundant.

408. Septoria conspicua, Ell. & Martin.
On *Steironema ciliatum*, Raf. Racine. Common and abundant.

409. Septoria cornicola, Desm.
On *Cornus sericea*, L. Madison. (Seymour.) On *Cornus alternifolia*, L., and *C. paniculata*, L'Her. Racine. *C. alternifolia*, L. Lake Geneva. Common.

410. Septoria corylina, Peck.
On *Corylus rostrata*, Ait. Three Lakes.

411. Septoria cratægi, Kickx.
On *Cratægus tomentosa*, L. Racine. Not common.

412. SEPTORIA CRYPTOTÆNIÆ, Ell. & Rau.
On *Cryptotœnia Canadensis*, DC. Madison. (Seymour.) Racine. Very common and abundant. *Septoria saniculæ*, E. & E., should doubtless be placed here, the host plant having been erroneously determined.

413. SEPTORIA CUCURBITACEARUM, Sacc.
On leaves of musk melon (*Cucumis Melo*, L.) Racine. This was observed to be rather abundant in that portion of a musk melon patch that was shaded from the west by a windbreak of trees.

414. SEPTORIA DIERVILLÆ, E. & E.
On *Diervilla trifida*, Moench. Racine.

415. SEPTORIA EPILOBII, West.
On *Epilobium coloratum*, Muhl. Madison. (Trelease and Seymour.)

416. SEPTORIA FUSARIOSPORA, E. & E.
On *Erigeron strigosus*, Muhl. Waterford.

417. SEPTORIA HELENII, E. & E.
On *Helenium autumnale*, L. Racine. Common. Occasionally the perithecia are formed on large, ill-defined, discolored areas instead of definite spots.

418. SEPTORIA HELIANTHI, Ell. & Kell.
On *Helianthus strumosus*, L., *H. annuus*, L., *H. grosse-serratus*, Martens, and other species. Racine. "On young seedling *Helianthus*, perhaps *H. grosse-serratus.*" Madison. (Trelease.) Common and abundant. Sometimes hypophyllous.

419. SEPTORIA INCRESCENS, Peck.
On *Trientalis Americana*, Pursh. Racine and Three Lakes.

420. SEPTORIA INTERMEDIA, E. & E.
On *Solidago*. Racine. Rare.

421. SEPTORIA LACTUCAÆ, Pass.
On *Lactuca Scariola*, L. Waukesha.

422. SEPTORIA LAPPARUM, Sacc.
On *Lappa*. Madison. (Trelease and Seymour.)

423. SEPTORIA LEPTOSTACHYA, Ell. & Kell.
On *Phryma Leptostachya*, L. Madison. (Seymour.) Racine. Abundant.

424. SEPTORIA LOBELIÆ, Peck.
On *Lobelia syphilitica*. Racine and Genoa Junction. On *L. spicata*, Lam., *L. cardinalis*, L., and *L. inflata*, L. Racine. Common.

425. SEPTORIA LUDWIGIÆ, Cke.
On *Ludwigia palustris*, Ell. Racine.

426. SEPTORIA LYSIMACHIÆ, West.
On *Steironema longifolium*, Gray. Delavan and Racine. Rather scarce.

427. SEPTORIA MELANDRII, Pass.
On *Lychnis vespertina*, Sibth. Racine. Rare.

428. SEPTORIA MIMULI, E. & Kell.
On *Mimulus ringens*, L. Racine. Not rare.

429. SEPTORIA NEPETÆ, E. & E.
On *Nepeta Cataria*, L. Kenosha county. Collected but once and in small quantity.

430. SEPTORIA NOCTIFLORÆ, E. & Kell.
On *Silene noctiflora*, L. Racine. Rare. Mr. Ellis thinks this may prove to be identical with *S. saponariæ*, (DC.)

430*a*. SEPTORIA OSTYRA, Peck.
On *Ostrya Virginica*, Willd. Racine.

431. SEPTORIA PACHYSPORA, E. & Holway.
On *Xanthoxylum Americanum*, Mill. Racine. No colored border to the spots in my specimens from Racine. Not scarce in the single station known to me.

432. Septoria pæoniæ, West. (?)
On *Pæony*. Madison. (Pammel, com. Trelease.)

433. Septoria passerinii, Sacc.
On *Hordeum jubatum*, L. Racine. Apparently not common.

434. Septoria physostegiœ, E. & E.
On *Physostegia Virginiana*, Benth. Racine.

435. Septoria pileæ, Thum.
On *Pilea pumila*, Gray. Racine.

436. Septoria plantaginis, Pass. (?)
On *Plantago major*, L. Madison. (Trelease.)

437. Septoria podophyllina, Peck.
On *Podophyllum peltatum*, L. Racine. Common.

438. Septoria prenanthis, E. & E.
On *Prenanthes*, sp. Racine. Not uncommon.

439. Septoria psilostega, E. & Martin.
On *Galium*. Racine.

440. Septoria pteleæ, E. & E.
On *Ptelea trifoliata*, L. Racine. Rather abundant on the few host plants known to me.

441. Septoria rhuina, B. & C.
On *Rhus glabra*, L. Kansasville. Not scarce.

442. Septoria sambucina, Peck.
On *Sambucus Canadensis*, L. Racine. Not abundant.

443. Septoria saponariæ, (DC.)
On *Silene antirrhina*, L. Kansasville.

444. Septoria scutellariæ, Thum.
On *Scutellaria galericulata*, L. Wind Lake, Racine county. *S. lateriflora*, L., Racine.

445. Septoria sicyi, Peck.
On *Echinocystis lobata*, Torr. & Gr. Racine. Not common.

446. Septoria sii, Rob. & Desm.
On *Sium cicutæfolium*, Gmel. Burlington and Racine. Not uncommon.

447. SEPTORIA SILENES, West.
On *Silene noctiflora*, L. Racine. Rare.

448. SEPTORIA SILENICOLA, Sacc.
On *Silene stellata*, Ait. Racine. Rare.

449. SEPTORIA SMILACINÆ, E. & M.
On *Smilacina*. Racine.

450. SEPTORIA SOLIDAGINICOLA, Peck.
On *Solidago serotina*, Ait., *S. Canadensis*, L., and *Aster Shortii*, Hook. Racine. Common and abundant.

451. SEPTORIA SPECULARIÆ, B. & C.
On *Specularia perfoliata*, A. DC. Kansasville.

452. SEPTORIA SPICULOSA, E. & Holway.
On *Symplocarpus fœtidus*, Salisb. Racine and Lake Geneva. Rather common.

453. SEPTORIA STACHYDIS, Rob. & Desm.
On *Stachys aspera*, Michx. Racine. Not scarce.

454. SEPTORIA STELLARIÆ, Rob. & Desm.
On *Stellaria media*, Smith. Racine. Not common.

455. SEPTORIA TRILLII, Peck.
On *Trillium erectum*, L., *T. cernuum*, L., *T. grandiflorum*, Salisb., and *T. recurvatum*, Beck. Racine. Common. On the white flowered species the spots are larger, more irregular in shape, and nearly black, but when mature with a gray center.

456. SEPTORIA UMBELLIFERARUM, Kalch.
On *Cicuta maculata*, L., and *Tiedemannia rigida*, Coult. & Rose. Racine.

457. SEPTORIA VERBENÆ, Rob. & Desm.
On *Verbena hastata*, L., and *V. urticæfolia*. L. Racine. Common.

458. SEPTORIA VERONICÆ, Desm.
On *Veronica arvensis*, L. Racine. Rather abundant. Specimens on *V. Virginica*, L., collected at Racine and Sharon, are referred here with some doubt by Mr. Ellis.

UREDINEÆ.

459. URO MYCES POÆ, Rabh.

Uredo- and teleutospores on *Glyceria fluitans*, R. Br. Racine. Referred here by Prof. Charles H. Peck. Not scarce in a single station now nearly destroyed by pasturing.

460. UROMYCES SCIRPI, Burrill.

Teleutospores on *Scirpus fluviatilis*, Gray. Racine. Not scarce.

461. PUCCINIA ANGUSTATA, Peck.

Uredo and teleutospores on *Scirpus atrovirens*, Muhl., and *Eriophorum lineatum*, B. & H. Racine. Not uncommon.

462. PUCCINIA CARICIS-STRICTÆ, Dietel., (*Uromyces caricis*, Peck.)

Uredo and teleutospores on *Carex gracillima*, Schw. Berryville.

463. PUCCINIA CYPERI, Arthur.

Teleutospores on *Cyperus strigosus*, L. Genoa Junction and Kansasville. The specimens referred to *Puccinia caricis*, (Schum.) in the Preliminary List, collected on *Cyperus Schweinitzii*, Torr., at Madison (Trelease), LaCrosse and Honey Creek (Pammel), should now be referred here. (J. C. Arthur, Botanical Gazette, XVI—8-226.)

464. PUCCINIA ELEOCHARIDIS, Arthur.

A few sori on a single plant of *Eleocharis*, *sp. indet.*, were found near Kansasville.

465. PUCCINIA MARIÆ-WILSONI, Clinton.

Æcidium and teleutospores on *Claytonia Virginica*, L. Racine. Not common.

465*a*. PUCCINIA MESOMEGALA, B. & C.

On *Clintonia borealis*, Raf. Bayfield (Holway).

466. Puccinia obtecta, Peck.

Uredo and teleutospores not uncommon on *Scirpus lacustris*, L., at Racine. Abundant along the shores of Eagle Lake near Kansasville on *Scirpus pungens*, Vahl.

467. Puccinia porphyrogenita, Curtis.

On *Cornus Canadensis*, L. Bayfield (Holway.)

468. Puccinia proserpinacæ, Farlow.

On *Proserpinaca palustris*, L. Racine. A single station where it is somewhat abundant.

469. Puccinia spreta, Peck.

On *Mitella diphylla*, L. Racine. I am indebted to Prof. C. H. Peck for the determination.

470. Puccinia saniculæ, Grev.

Æcidium, uredo and teleutospores on *Sanicula Marylandica*, L. Racine. Rare and scarce.

471. Puccinia saxifragæ, Schl.

On *Heuchera Americana*, L. Madison. (H. L. Russell.)

472. Puccinia suaveolens, (Pers.) Rostrup.

Spermogonia, uredo and teleutospores on *Cnicus arvensis*, Hoffm. Racine. Common.

473. Puccinia veronicæ, (Schum.) Winter.

Teleutospores on *Veronica Virginica*, L. Racine. Rare and scarce.

474. Triphragmium clavellosum, Berk.

On *Aralia*. Bayfield. (Holway.)

475. Coleosporium viburni, Arthur.

On *Viburnum Lentago*, L. Uredo and teleutospores. Racine. Not common, but sometimes rather abundant.

476. Chrysomyxa ledi, (A. & S.) DBy.

Uredo on *Ledum latifolium*, Ait. Three Lakes. Abundant

477. CRONARTIUM ASCLEPIADEUM, Kze., var. THESII, B.
On *Comandra umbellata*, Nutt. Racine.

478. MELAMPSORA EPILOBII, (Pers.) Fckl.
Uredo on *Epilobium coloratum*, Muhl. Racine. Not uncommon nor scarce.

479. MELAMPSORA SPARSA, Winter.
On *Arctostaphylos uva-ursi*, Sprengel. This has not been compared with authentic specimens, but is probably correctly placed. From my experience in collecting it I am led to think the specific name a very appropriate one. Three Lakes.

480. UREDO CASSANDRÆ, Peck & Clinton.
On *Cassandra calyculata*, Don. Three Lakes. Abundant.

481. ÆCIDIDIUM ACTAEÆ, (Opiz.) Wallr.
On *Actaea*, sp. Baraboo. (True, com. Trelease.) Racine. Rare.

482. ÆCIDIUM CLEMATIDIS, DC.
On *Clematis Virginiana*, L. Racine. Not scarce.

483. ÆCIDIUM NESAEÆ, Gerard.
On *Decodon verticillatus*, Ell. Genoa Junction. Rare.

484. ÆCIDIUM HYDNOIDEUM, B. & C.
A single sorus was found on a leaf of *Dirca palustris*, L., at Three Lakes.

484*a*. ÆCIDIUM POROSUM, Peck.
On *Vicia Americana*, Muhl. Racine. Rather abundant.

485. ÆCIDIUM RHAMNI, Gmel.
This species, the supposed æcidial stage of *Puccinia coronata*, Corda, was found in small quantity near Racine and in abudance near Wind Lake, in Racine county, on *Rhamnus alnifolia*, L'Her.

Entomophthoreæ.

486. Empusa grylli, Fres.
"Very common at Madison on *Caloptenus.*"—Trelease.

Ustilagineæ and Allies.

487. Entyloma floerkeæ, Holway.
On *Floerkea proserpinacoides*, Willd. Racine. Abundant, but conidia scarce.

488. Entyloma saniculæ, Peck.
On *Sanicula Marylandica*, L. Racine. Rather common, but, as with the preceding species, the conidia are scarce.

489. Protomyces fuscus, Peck.
On *Hepatica acutiloba*, DC. Racine. On *Hepatica triloba*, Chaix. Waterford. Rare.

490. Protomyces macrosporus, Unger.
A few sori, agreeing with the description of this species, were found on the stem of *Cicuta maculata*, L., near Kansasville. Although the host was abundant, no more was found after considerable search.

491. Tubercinia trientalis, B. & Br.
On *Smilacina.* Racine. Found but once.

492. Tuberculina persicina, Ditm.
On *Æcidium impatientis*, Schw. Racine. Rare.

493. Urocystis waldsteiniæ, Peck.
On *Waldsteinia fragarioides*, Tratt. Three Lakes.

Sclerotia.

494. Sclerotium nervale, A. & S.
On *Viola pubescens*, Ait. Berryville. Rare and scarce.

495. During one season a grey, globular sclerotium was very common on large compositæ, *Silphium*, *Helianthus*, etc., falling from the leaves when full

grown. In spite of its abundance that year I have not seen it since. In 1892 a similar sclerotium was observed on *Calamogrostis Canadensis,* Beauv., at Berryville, which distorted the plants in a peculiar manner. The affected leaves were curled longitudinally, beginning at the tip which dropped to the leaf below, where it was firmly held by the inrolling of the under leaf. The sclerotia were cinereous, globular, about 2 mm. in diameter, and were enclosed in the rolled up leaf.

INDEX TO HOSTS.

ON THE CYCLOPIDÆ AND CALANIDÆ OF CENTRAL WISCONSIN.

By C. Dwight Marsh.

The material on which this paper is based has been largely collected from the immediate vicinity of Ripon. The fauna of Green Lake I have been enabled to study with considerable thoroughness; I have not only made a large number of collections, but they have been made at all seasons from early spring to December, and the work has extended over several years. From some ponds in the neighborhood of Ripon, I have made similar repeated collections. From Lake Puckaway, Lake Winnebago, and the smaller lakes in Fond du Lac and Green Lake counties, my collections were for the most part made in the months of July and August.

Through the kindness of Prof. E. A. Birge, I have also had material collected by him from lakes in the northern part of the state, and by Miss H. Merrill from the Great Lakes.

This is not presented as a final report, for I still feel very doubtful in regard to the relationships of some species. But to properly define these relationships seems likely to involve a long period of study, and possibly it cannot be done satisfactorily until more is known of the embryonic and larval stages. Inasmuch as so little has been published in regard to American copepoda, I may be justified in publishing this paper, although I am well aware of its imperfections.

While faunistic studies of fresh-water crustacea have been quite thoroughly prosecuted in Europe, and to some extent in Asia and Africa, only a few localities in the United States have been studied with any degree of thoroughness. The only considerable publications on copepoda have been made by Prof. Forbes, Prof. Cragin and Prof. Herrick. Prof. Forbes, who has made very important additions to our knowledge of

American entomostraca, made his collections in Illinois, southern Wisconsin, the Great Lakes, and Montana and Wyoming. Prof Cragin collected in eastern Massachusetts. Prof. Herrick has collected very widely through the Mississippi valley and the southern states. His reports on the Minnesota crustacea (**22, 25, 26**) covered a region with a fauna nearly identical with that of Wisconsin. His work of exploration must have been done very thoroughly, for my work in Wisconsin gives me little to add in the way of new species. Because of incomplete descriptions or a lack of figures, it is, in some cases, however, difficult to identify his species.

In Wisconsin the cladoceran fauna is better known than in any other part of the United States through the well-known work of Prof. Birge, but the copepoda have been almost entirely neglected.

While the number of copepods in a collection from any locality is frequently very large, the number of species is generally small. In pools which are swarming with individuals, frequently there are not more than two or three species. In pelagic collections there are seldom more than four to six species. Of diaptomus there is ordinarily only one species in a locality, although two or three species are sometimes found together in pelagic collections.

Some species of copepods may be considered strictly pelagic, and some as strictly littoral, while others are found only in stagnant pools. But many species readily adapt themselves to all these conditions, and with little or no change of structure seem to thrive equally well wherever they may be.

The following may be considered a fairly accurate division of the species according to their habitat:

	Pelagic.	Littoral.	Stagnant Pools.
Diaptomus sanguineus	......	......	x
" *leptopus*	......	......	x
" *pallidus*	......	x	......
" *sicilis*	x	......	......
" *ashlandi*	x	......	......
" *minutus*	x	......	......
" *oregonensis*	x	......	......
Epischura lacustris	x	......	......
Limnocalanus macrurus	x	......	......
Cyclops americanus	......	x	x
" *brevispinosus*	x	x	......
" *navus*	......	......	x
" *pulchellus*	x	......	......
" *parcus*	......	......	x
" *leuckarti*	x	x	......
" *signatus*	x	x	x
" *modestus*	......	x	......
" *fluviatilis*	x	......	......
" *serrulatus*	x	x	x
" *phaleratus*	......	......	x
" *bicolor*	......	......	x
" *fimbriatus*	......	......	x

None of our species is peculiar to this immediate region, and it is probable that they are widely distributed over the northern part of the United States and the southern part of British America. Indeed, the copepod fauna of North America resembles very closely that of Europe and northern Asia. This fact has already been remarked by Prof. Birge in regard to the cladocera, and it seems no less true of the copepoda. Many of our species are identical with those of Europe, even in the minutest details, as in the case of *Cyclops leuckarti* Sars. In other cases the structural differences are slight, and it is very probable that we should consider them of only varietal value, were we acquainted with the limits of species variation. That the species should be identical, or nearly so, over such a wide extent of territory is not at all strange when we remember how easily the living animals and their eggs may be transported by water-fowl. Most of the forms, too, seem to readily adapt themselves to change of environment with little perceptible change of structure. Thus *Cyclops pulchellus* Koch, is a common pelagic form of the larger lakes, and seems well adapted to its environment, but I have found it in Rush Lake, a reed-covered, shallow body of water, in which we would hardly expect to find any distinctive pelagic fauna.

It is to be noticed that the American species of *Diaptomus* are distinct from those of Europe, and that they are, in some cases, quite limited in their distribution.

The pelagic species are generally colorless, and the body and appendages are more elongated than in the littoral forms. When a species occurs both in shallow and in deep water, the same difference is noted, the pelagic forms in some cases forming well marked varieties.

The species of shallow water and stagnant pools are frequently highly colored, but the color is generally of little value in distinguishing species. Quite generally all the copepoda and cladocera of a pool have the same prevailing color, while the same species under other conditions of environment may be entirely colorless. This was noticed by Herrick in 1883 (**25** p. 385.) Certain species, however, seem to have a coloration peculiarly their own,—like the purple tips of the antennæ in *Diaptomus leptopus.* The specimens of *Cyclops modestus* which I have found, have possessed a distinct purple tinge, very different from the colors of the species with which they were associated.

In the synonomy of species I have followed the European authors. It seems to me next to an impossibility to identify the species of Koch and Baird, for their descriptions are of no value whatever. All that is left for one to do is to accept them as defined by later authors.

It has not been my aim to add to the already sufficiently numerous descriptions of "new species," but rather to make more clear the descriptions already given, to indicate the proper synonymy, and to reduce the number of specific names rather than to increase them. In doing this, I know I have laid myself open to criticism, for it is, perhaps, presuming too much to revise another author's descriptions. My only excuse is my reluctance to add to the cumbersome nomenclature of the genera under discussion. For example, I have no doubt of the identity of a Wisconsin species with *Cyclops brevispinosus* Herrick, but Herrick's description is not sufficient for a satisfactory identification. Therefore, rather than to add a new species name, I have ventured to describe this species more completely.

Inasmuch as printed descriptions, even when accurate, are frequently misleading, and as a list of species is only valuable when one is certain of the accuracy of the identification, I have, in most cases, drawn figures of the essential anatomical characteristics of the species treated of, and trust that I shall have made clear at least what species I have described, and have rendered it possible, if I have made mistakes, for others to detect those mistakes.

	Green Lake.	Little Green Lake.	Lake Winnebago.	Twin Lakes.	Spring Lake.	Rush Lake.	Heart Lake.	Lake Puckaway.	Lake Minocqua.	Great Lakes.	Stagnant Pools.
Diaptomus sanguineus	..	..	..	..	..	..	..	..	..	..	x
" *leptopus*	..	..	..	..	..	..	..	..	..	..	x
" *pallidus*	..	..	..	..	..	..	x	..	..	..	..
" *sicilis*	x	..	..	..	..	..	..	..	..	x	..
" *ashlandi*	..	..	..	..	..	..	..	..	..	x	..
" *minutus*	x	..	..	..	..	..	..	..	..	x	..
" *oregonensis*	..	x	x	x	..	..	..	..	x	x	..
Epischura lacustris	x	..	..	..	..	..	..	x	..	x	..
Limnocalanus macrurus	x	..	..	..	..	..	..	..	..	x	..
Cyclops americanus	x	x	..	..	..	x	..	..	..	..	x
" *brevispinosus*	x	x	x	x	x	x	x	x	x	x	..
" *navus*	..	..	..	..	..	..	..	..	..	..	x
" *pulchellus*	..	..	..	..	..	x	..	..	x	x	..
" *parcus*	..	..	..	..	..	..	..	..	..	..	x
" *leuckarti*	x	x	x	x	x	x	x	x	x	x	..
" *signatus*	x	x	..	..	x	x	x	x	x	..	..
" *modestus*	..	..	..	..	..	x	..	..	..	..	..
" *fluviatilis*	x	x	..	..	..	..	..	..	x	..	..
" *serrulatus*	x	x	x	x	x	x	x	x	x	x	x
" *phaleratus*	x	x	..	..	x	x	..	..	..	..	x
" *bicolor*	..	..	..	..	..	..	..	..	..	..	x
" *fimbriatus*	..	..	..	..	..	..	..	..	..	..	x

The foregoing table will give an idea of the distribution of the species in some of the bodies of water which I have examined. Green Lake is about seven miles long and has a maximum depth of a little less than two hundred feet. The other lakes—the Great Lakes excepted—are shallow. Lake Winnebago, although a large body of water, is said to be nowhere more than twenty-five or thirty feet in depth. Rush Lake is pretty largely covered with a growth of rushes and wild rice, and is being gradually filled up. Lake Puckaway is an expansion of Fox river, is to a considerable extent covered with wild rice and rushes, and is very shallow.

FAMILY CALANIDÆ.

Genus DIAPTOMUS Westwood.

KEY TO SPECIES OF DIAPTOMUS FROM CHARACTERISTICS OF MALE.

Antepenultimate joint of antenna without appendage,
- Fifth feet nearly equal in length, *oregonensis.*
- Left fifth foot shorter than right, *pallidus.*

Antepenultimate joint of antenna with hyaline lamella, *leptopus.*

Antepenultimate joint of antenna with appendage,
- Appendage short and blunt, *sanguineus.*
- Appendage as long or longer than penultimate joint,
  - Terminal hook of right fifth foot broad, lateral spine minute, *minutus.*
  - Terminal hook falciform,
    - Lateral spine nearer outer extremity of joint, *sicilis.*
    - Lateral spine stout, near base of joint, *ashlandi.*

Diaptomus sanguineus Forbes.

Plate III. Figs. 1–3.

1876. *D. sanguineus* Forbes (**17**) pp. 15, 16 and 23, figs. 24, and 28–30.
1882. *D. sanguineus* Forbes (**22**) p. 647, pl. VIII, figs. 1–7, and 13.
1884. *D. sanguineus* Herrick (**26**) p. 138, pl. Q, fig. 12.
" " *minnetonka* Herrick (**26**) p. 138, pl. Q, figs. 8–10.
1889. " *sanguineus* DeGuerne and Richard (**32**) p. 20, pl. IV, fig. 24.

This species, which is found in pools in the spring months, is readily recognized by the characters of the male antennæ and fifth feet. My specimens differ in minute particulars from the figures given by Forbes; the lateral spine on the terminal joint of the outer ramus of the right fifth foot in the male is nearer the distal end of the joint, while Forbes's figure makes its position nearly median; the blunt spine on the inner angle of the second joint of this foot is a little longer than the spine at the outer angle, instead of shorter, as in his figure.

D. minnetonka Herrick is probably a variety of *D. sanguineus.*

Diaptomus leptopus Forbes.

Plate III. Figs. 4 and 5.

1882. *D. leptopus* Forbes (**22**) p. 646, pl. VIII, figs. 17–19.
1884. " *longicornis* var. *leptopus* Herrick (**26**) p. 140.
1889. " *leptopus* DeGuerne and Richard (**32**) pl. II, fig. 19, pl. III, fig. 9.

Forbes, in his description, states that the antepenultimate segment of the right male antenna bears a small hook. I have failed to find a hook in my specimens; the segment is armed only with a very inconspicuous hyaline lamella. DeGuerne and Richard have also noted the absence of the hook.

It is quite common in the summer and fall months. As I have found it, it has been of a brownish red color, much like *D. sanguineus*, with purple tipped antennæ and caudal setæ.

D. kentuckyensis Chambers, is probably identical with *leptopus*, although the imperfect figures make it impossible to decide with certainty.

DIAPTOMUS PALLIDUS Herrick.

Plate III. Figs. 6, 7 and 9.

1879. *D. pallidus*, Herrick (**18a**) p. 91, pl. II, a–d.
1884. " " " (**26**) p. 142, pl. Q, fig. 17.
1889. " " DeGuerne and Richard (**32**) p. 62, fig. 17.

A small, slender species. Cephalothorax elongated oval, widest at about the middle; the last segment is armed with two minute lateral spines.

The first abdominal segment of the female is as long as the remaining part of the abdomen, and is dilated laterally. The second abdominal segment is shorter than the third. The furcal joints are about twice as long as broad.

The antennæ reach beyond the furca. The right antenna of the male is swollen anterior to the geniculating joint; it bears no appendage on the antepenultimate joint.

The outer ramus of the fifth foot of the female is two-jointed; the third joint is represented by two blunt spines. The inner ramus is one-jointed, equaling in length the first joint of the outer ramus; it is armed with a short spine at tip, and two larger ones on inner margin of tip; the inner surface of the tip is covered with short hairs.

The fifth feet of the male are slender, with the basal joints nearly equal in length. The first joint of the outer ramus of the right foot is a little shorter than the basal joint. The second joint is nearly twice as long as the first; on its inner margin at about a third of its length is a short spine-like projection; the lateral spine is slender, situated near the outer end of the joint. The terminal hook is falciform, but not with a regular curvature, and is about once and a half the length of the second joint. The inner ramus is slender, one-jointed, as long as the first joint of the outer ramus.

The left foot extends to nearly one half the length of the second joint of the outer ramus of the right. The first joint of the outer ramus is about as long as the first joint of the outer ramus of the right foot. The second joint terminates in two projections,—a blunt finger-like process on the exterior side, with a pad armed with minute spines on its inner surface, and a slender falciform process from the inner margin, which curves over and nearly meets the process on the outer margin. There is also a small blunt projection on the inner margin of the joint. The inner ramus is slender, one-jointed, and equals in length the first joint of the outer ramus.

Length of the male, .875 mm.; of the female, 1.01 mm.

Locality, Heart Lake, near Marquette.

Herrick's descriptions of *D. pallidus* are not sufficient to identify the species, and his figures in the report of 1878 do not help the matter. In the final report on the Minnesota Crustacea, there is but one figure of *pallidus*—that of the left fifth foot of the male—and it is mainly from this figure that I have considered *D. pallidus* identical with my specimens. I have not found it quite as large as stated by Herrick, but in other respects it corresponds quite well with his descriptions, and it does not seem best to introduce a new name.

I have found *D. pallidus* in only one locality—Heart Lake, a small shallow lake south of Marquette.

Diaptomus sicilis Forbes.

Plate III. Figs. 8 and 10.

1882. *D. sicilis* Forbes (**22**) p. 645, pl. VIII, figs. 9 and 20.
1884. " " Herrick (**26**) p. 142, pl. Q, fig. 18.
1889. " " DeGuerne and Richard (**30**) p. 23, figs. 13 and 14, pl. II, fig 13.
1891. *D. sicilis* Forbes (**35**) p. 702, pl. 1, fig 6.

This species, which is abundant in the Great Lakes, I found as a common pelagic species in Green Lake in the summers of 1890 and 1891. In a large number of collections made in 1892, however, I did not find a single individual. This seems particularly strange, as the collections in 1892 were made at about the same seasons as in the preceding years.

The Green Lake specimens differ slightly from Forbes's type. They are somewhat smaller, the males averaging .9 mm., and the females 1.08 mm. The inner rami of the male fifth feet are not evidently two-jointed.

Diaptomus ashlandi sp. nov.

Plate III. Figs. 11–13.

A small pelagic species closely resembling *D. sicilis* Forbes. In form it is slender, hardly to be distinguished from *D. sicilis* and *D. minutus*.

The first joint of the abdomen in the female is longer than the remaining part of the abdomen, is dilated at the sides, and bears two minute lateral spines. The second and third joints are so closely united that the abdomen appears two-jointed. The furcal joints are about twice as long as broad.

The antennæ reach just beyond the furca. The right antenna of the male is much swollen anterior to the geniculating joint, and bears on the antepenultimate joint an appendage slightly exceeding in length the penultimate joint. This appendage may be blunt pointed or slightly enlarged at the extremity.

The fifth feet of the female are rather slender; the outer ramus is two-jointed. The third joint is represented by two short spines. The inner ramus is one-jointed, a little longer than the first joint of the outer ramus, armed at tip with two rather long spines.

The fifth feet of the male are slender. The basal joint of the right foot is about twice as long as that of the left. The first joint of the outer ramus is a little wider than long. The second joint is wider at the inner than at the outer end; the lateral spine is stout, curved, situated near the inner end. The terminal hook is slender and falciform. The inner ramus is slender, one-jointed, and about one-third longer than the first joint of the outer ramus.

The left foot extends a little beyond the first joint of the outer ramus of the right. The second joint of the outer ramus has three blunt spines upon its apex and is armed with minute bristles within. The inner ramus is slender, one-jointed, and reaches about half the length of the second joint of the outer ramus.

Length of male, .89 mm.; female, .97 mm.

Localities, Lake Superior and Lake Erie.

D. ashlandi is smaller than *D. sicilis*, from which it is distinguished by the form of the male fifth feet. The appendage of the antepenultimate joint of the right male antenna resembles the form in *sicilis* and *minutus.* The female is not so readily distinguished, although the fifth feet are more slender than in *sicilis.*

I have specimens from only two localities. In pelagic collections made by Prof. Birge at Ashland it occurred with *D. oregonensis* and *D. minutus.* In a collection made by Miss Merrill on Lake Erie nearly all the *Diaptomi* belonged to this species, *D. sicilis* being represented very sparingly.

DIAPTOMUS MINUTUS Lilljeborg.

Plate IV. Figs. 1–3.

1889. *Diaptomus minutus* DeGuerne and Richard (Lilljeborg) (**32**) p. 50, pl. I, figs. 5, 6 and 14, pl. III, fig. 25.
1891. *Diaptomus minutus* Marsh (**38**) p. 212.

I reported *D. minutus* in 1891 from Green Lake. I have since found it in collections from the Great Lakes, the St. Clair river, and one lake in northern Wisconsin. It was described by Lilljeborg from specimens obtained in Greenland and Newfoundland. It was later reported from Iceland (**39**).

It is probable, as stated by DeGuerne and Richard, that it is a common species through the northern part of North America. It is common in the pelagic collections from Green Lake, but I have found it nowhere else in central Wisconsin; it is possible that this is near the southern limit of the species. The stout terminal claw of the outer ramus of the right fifth foot in the male, and the short, leaf-like inner rami of the fifth foot of the female, make this species one easily recognized.

DIAPTOMUS OREGONENSIS Lilljeborg.

Plate IV. Figs. 4 and 5.

1889. *D. oregonensis* DeGuerne and Richard (Lillj.) (**32**) p. 53, pl. II, fig. 5, pl. III, fig. 8.

This is the most common species of *diaptomus*, being found quite generally in the shallower lakes. It is easily distinguished from the other species by the form of the male fifth foot.

The type specimens were obtained from Portland, Oregon, and according to the figures in DeGuerne and Richard's "Revision" are somewhat more slender in all their parts than are my specimens.

GENUS EPISCHURA Forbes.

EPISCHURA LACUSTRIS Forbes.

Plate IV. Fig. 6.

1882. *E. lacustris* Forbes (**22**) pp. 541 and 648, pl. VIII, figs. 15, 16, 21, 23, pl. IX, fig. 8.

1884. *E. lacustris* Herrick (**26**) p. 131, pl. Q, fig. 13.

1889. " " DeGuerne and Richard (**32**) p. 90, pl. IV, figs. 3, 9 and 10.

1891. *E. lacustris* Forbes (**35**) p. 704, pl. I, figs. 1–5, pl. II, fig. 7.

I have found *E. lacustris* in only two localities beside the Great Lakes—in Green Lake and Lake Puckaway. Probably, however, it is abundant in other localities, as Forbes reports it from many lakes in Illinois, Michigan, and southern Wis r sin.

The peculiar form of the male abdomen distinguishes nis in a striking manner from all other copepods.

GENUS LIMNOCALANUS Sars.

LIMNOCALANUS MACRURUS Sars.

Plate IV. Fig. 7.

1863. *L. macrurus* Sars (**11**) pp. 228–229.
1882. " " Forbes (**22**) p. 648.
1886. *Centropages grimaldi* DeGuerne (**29**) pp. 1–10.
1888. *L. macrurus* Nordqvist (**31**) pp. 31–37, pl. I, figs. 9–11; pl. II figs. 1–5; pl. III figs. 1–4.
1889. *L. macrurus* DeGuerne and Richard (**32**) p. 77, pl. IV, figs. 5, 11 and 12.
1891. *L. macrurus* var. *auctus* Forbes (**35**) p. 706.

L. macrurus is abundant in Green Lake. It is a species of especial interest because of its wide distribution. It is found quite generally throughout northern Europe. Forbes has found it in Lake Michigan, Lake Superior and Lake Geneva. I have found it also in collections from Lake Huron, Lake St. Clair, and the St. Clair river.

FAMILY CYCLOPIDÆ.

GENUS CYCLOPS Mueller.

KEY TO THE WISCONSIN SPECIES OF CYCLOPS.

Antennæ 17-jointed, fifth foot two-jointed,
  Second joint of fifth foot armed with seta and short spine,
    Terminal joint of outer branch of swimming feet armed externally with three spines,
      Furca of moderate length, *americanus.*
      Furca elongated, *brevispinosus.*
    Terminal joint of outer branch of swimming feet armed externally with two spines, *parcus.*
  Second joint of fifth foot with two terminal setæ,
    Furca short, *navus.*
    Furca elongated, *pulchellus.*
  Second joint of fifth foot, with one terminal and one lateral seta, *leuckarti.*
  Second joint of fifth foot, with three setæ, *signatus.*
Antennæ 16-jointed, fifth foot 3-jointed, *modestus.*
Antennæ 12-jointed, fifth foot 1-jointed,
  Furca variable in length, armed externally with a row of small spines, *serrulatus.*
  Furca short, without armature of spines, *fluviatilis.*
Antennæ 11-jointed, swimming feet three-jointed, *phaleratus.*
  swimming feet two-jointed, *bicolor.*
Antennæ 8-jointed, *fimbriatus.*

CYCLOPS AMERICANUS sp. nov.

Plate IV. Figs. 8–10.

1882. *C. ingens* Herrick (**23**) p. 228, pl. V, figs. 1–8.
1883. " *viridis* Cragin (**24**) p. 3, pl. IV, figs. 8–16.
1884. " " Herrick (**26**) p. 145.

Cephalothorax oval, the first segment being about half its total length. Antennæ 17-jointed, about as long as first cephalothoracic segment. Abdomen rather slender, the last segment armed on its posterior border with small spines. All the abdominal segments in immature individuals are strongly pectinated posteriorly. Furca about three times as long as its average breadth, the lateral spine situated well towards the end. The first and fourth terminal setæ are short, slender and plumose, nearly equal in length. Of the internal setæ, the outer is a little more than three-fourths the length of the inner.

The armature of the terminal joints of the swimming feet is as follows:

FIRST FOOT.

Outer br.	ex. 3 spines.	Inner br.	ex. 1 seta.
	ap. 2 setæ.		ap. 1 spine, 1 seta.
	in. 2 setæ.		in. 3 setæ.

SECOND AND THIRD FEET.

Outer br.	ex. 3 spines.	Inner br.	ex. 1 seta.
	ap. 1 spine, 1 seta.		ap. 1 spine, 1 seta.
	in. 3 setæ.		in. 3 setæ.

FOURTH FOOT.

Outer br.	ex. 3 spines.	Inner br.	ex. 1 seta.
	ap. 1 spine, 1 seta.		ap. 2 spines.
	in. 3 setæ.		in. 2 setæ.

Fifth foot two-jointed, basal joint very broad, armed with one seta. Terminal joint armed with a seta and a blunt spine.

Length, 1.2 mm.

This takes the place in our fauna that is occupied by *C. viridis* Fischer, in Europe. In general form and appearance the two forms seem identical, and have been so considered by Herrick and Cragin. I have hesitated to propound a new species name, but it seems necessary. So far as Uljanin and Vosseler have figured *viridis* it corresponds to our species; but neither gives figures of the swimming feet. From the original description by Fischer our species differs markedly. According to his figure the antennæ reach to the third cephalothoracic segment, while in *americanus* they hardly exceed the first. He makes the furca about equal in length to the last abdominal segment; in *americanus* it equals or exceeds the last two segments. He gives a figure of "a foot," not designating which, but it corresponds to no one of the four in our species.

Sars says the terminal joint of the external ramus of the fourth foot has two external spines; *americanus* has three.

Brady's figure of the terminal joint of the outer branch of the fourth foot (**18**, pl. 20, fig. 7) corresponds to Sars' statement. He also figures the terminal joint of the inner branch (**18**, pl. 20, fig. 8,) which shows a very different armature from that in *americanus*.

Schmeil (**41**, p. 97, pl. VIII, figs. 12–14,) gives a more elab orate description of *viridis*. His formula for the spines of the swimming feet corresponds to the descriptions of the other European authors. Schmeil, however, does not consider the armature of the swimming feet as constant, and according to his view *americanus* should be a variety of *viridis*. In an examination of a large number of specimens from widely separated localities I have found no variation in the number and arrangement of the spines and setæ of *americanus*, and until such variation is shown, there seems to be no alternative but to institute a new species for the American form.

C. americanus is widely distributed. It occurs quite generally in stagnant pools, and is also found to some extent in lakes.

Cyclops brevispinosus Herrick.

Plate IV. Figs. 11 and 12.

1884. *C. brevispinosus* Herrick (**26**) p. 148, pl. S, figs. 7–11.

Cephalothorax oval, the first segment reaching about half its total length. Antennæ 17-jointed, shorter than first cephalothoracic segment. Abdomen slender, the last segment armed on its posterior border with a row of small spines. Furca slender, longer than the last two abdominal segments, lateral spine at two-thirds the distance from base to extremity. Of the terminal setæ, the outer is a short blunt spine, the inner slender and somewhat longer; the outer median seta rather more than two-thirds the length of the inner.

The armature of the terminal joints of the swimming feet is as follows:

FIRST FOOT.

Outer br.	ex.	3 spines.	Inner br.	ex.	1 seta.
	ap.	2 setæ.		ap.	1 spine, 1 seta.
	in.	2 setæ.		in.	3 setæ.

SECOND FOOT.

Outer br.	ex.	3 spines.	Inner br.	ex.	1 seta.
	ap.	1 spine, 1 seta.		ap.	1 spine, 1 seta.
	in.	3 setæ.		in.	3 setæ.

THIRD FOOT.

Outer br.	ex.	3 spines.	Inner br.	ex.	1 spine.
	ap.	1 spine, 1 seta.		ap.	2 spines.
	in.	3 setæ.		in.	3 setæ.

FOURTH FOOT.

Outer br.	ex.	3 spines.	Inner br.	ex.	1 spine.
	ap.	1 spine, 1 seta.		ap.	2 spines.
	in.	3 setæ.		in.	2 setæ.

The fifth foot is two-jointed. The basal joint is very broad and is armed with one seta. The terminal joint is armed with one seta and a short spine.

Length about 1 mm.

Herrick's description of *C. brevispinosus* is so imperfect that it is difficult to identify the species with certainty. The armature of the swimming feet is different from that in *C. parcus*, although one might infer from his statement that it is the same. The form and armature of the furca, however, is characteristic, and his figure of the furca makes me so certain of the identity of the form, that I have ventured to redescribe the species rather than to propose a new name. It is easily recognized by its short, 17-jointed antennæ, and the elongated furca, with the outer terminal seta reduced to a short blunt spine.

It is widely distributed in lakes and ponds, and is a pelagic species, though sometimes occurring in littoral collections.

I have had some doubt as to whether this should be considered a distinct species. In most of its structural features it closely resembles *americanus*, and I have suspected it to be a pelagic variety of that species. I have specimens of *americanus* with elongated furca like *brevispinosus*, and I have specimens of *brevispinosus* in which the outer terminal seta of the furca is slender and plumose as in *americanus*. For the differences in the armature of the swimming feet, however, I have as yet found no intermediate forms, and so must, for the present at least, consider the two distinct.

Cyclops navus Herrick.

Plate IV. Figs. 13–15.

1882. *C. navus* Herrick (**23**) p. 229, pl. V, figs. 6–13, 15–17.
1884. " " " (**26**) p. 152.

Larger than *C. pulchellus*, the antennæ being about as long as first two segments of cephalothorax, as in that species. Armature of swimming feet as in *pulchellus*. Fifth foot armed as in *pulchellus*, but terminal joint more elongated, and its setæ more nearly equal in length, the inner being fully two-thirds the length of the outer. The furca is short, with the lateral seta on the posterior third; of the terminal setæ the first and fourth are short, the outer median about three-fifths as long as the inner.

It is generally reddish in color and occurs in pools. Herrick considers *navus* as probably a variety of *pulchellus*, and I am inclined to agree with him. The principal difference between the two species is in the form of the furca, and the difference is just that which we would expect from the difference of environment. It is just the difference which exists between the extreme forms of *serrulatus*. So far as I know, however, no one has reported forms intermediate between *C. pulchellus* and *C. navus*. In my collections, while I have seen many instances of considerable variation in *C. pulchellus*, particularly in the form and armature of the furca, I have found no forms which at all approach *C. navus*. Until such intermediate forms are discovered, *C. navus* must be considered distinct.

CYCLOPS PULCHELLUS Koch.

Plate IV. Figs. 18 and 19.

1838. *C. pulchellus* Koch (**3**) H. 21, pl. 2.
1857. " *bicuspidatus* Claus (**8**), p. 209, pl. XI, figs. 6 and 7.
1863, " " " (**9**), p. 101.
1863. " *pulchellus* Sars (**11**), p. 246.
1870. " *bicuspidatus* Heller (**12**), p. 71.
1872. " *bicuspidatus* Fric (**13**), p. 221, fig. 6.
1876. " *bicuspidatus* Hoek (**16**), p. 17, pl. I, figs. 7–11.
1880. " *pulchellus* Rehberg (**19**), p. 543.
1880. " *helgolandicus* Rehberg (**20**), p. 64, pl. IV, fig. 5.
1882. " *thomasi* Forbes (**22**), p. 649, pl. IX, figs. 10, 11 and 16.
1883. ,, *pectinatus* Herrick (**25**), p. 499, pl. VII, figs. 25–28.
1883. " *thomasi* Cragin (**24**), p. 3, pl. III, figs. 1–13.
1884. " *thomasi* Herrick (**26**), p. 151, pl. U, figs. 4, 5, 7 and 8.
1885. " *pulchellus* Daday (**27**), p. 220.
1886. " *pulchellus* Vosseler (**28**), p. 194, pl. V, figs. 19–28.
1891. " *thomasi* Forbes (**35**), p. 707, pl. II, fig. 8.
1891. " *bicuspidatus* Brady (**36**), p. 13, pl. 5, figs. 1–5.
1891. " *thomasi* Brady (**36**), p. 14, pl. VI, figs. 1–4.
1891. " *bicuspidatus* Schmeil (**37**), p. 27.
1891. " *bicuspidatus* Richard (**39**), p. 229, pl. VI, fig. 6.
1892. " *bicuspidatus* Schmeil (**41**), p. 75, pl. II, figs. 1–3.
1893. " *thomasi* Forbes (**42**), p. 249, pl. XXXIX, figs. 9–12; pl. XL, fig. 13.

Herrick considered *C. thomasi* a variety of *C. pulchellus* Koch. Brady also raises the question as to the specific distinction of the American form. I have gone over the literature of the subject with considerable care, and I can see no good reason for separating our American form from *C. pulchellus* Koch, or *bicuspidatus* Claus. All the European descriptions agree very closely with our form. We find in *C. thomasi* the same variations which Vosseler records in the European form,—for example, the variable position of the lateral spine of the furca. In general form, length of antennæ, form of furca and armature of swimming feet and fifth feet, it is difficult to find any clear distinction between the forms of the two continents. I cannot agree with Herrick and Brady in considering *C. bisetosus* Rehberg a synonym of *pulchellus*, for *pulchellus* has the swimming feet armed with two spines externally, while *bisetosus* has three, and my observations lead me to think that the armature of the swimming feet is quite constant.

The armature of the terminal joints of the swimming feet is as follows:

FIRST FOOT.

Outer br.	ex.	2 spines.	Inner br.	ex.	1 seta.
	ap.	2 setæ.		ap.	1 spine, 1 seta.
	in.	2 setæ.		in.	3 setæ.

SECOND AND THIRD FEET.

Outer br.	ex.	2 spines.	Inner br.	ex.	1 seta.
	ap.	1 spine, 1 seta.		ap.	1 spine, 1 seta.
	in.	3 setæ.		in.	3 setæ.

FOURTH FEET.

Outer br.	ex.	2 spines.	Inner br.	ex.	1 seta.
	ap.	1 spine, 1 seta.		ap.	2 spines.
	in.	3 setæ.		in.	2 setæ.

C. pulchellus occurs everywhere in the great lakes in pelagic collections, and in some of the smaller lakes of Wisconsin.

Cyclops parcus Herrick.

Plate IV, fig. 16; plate V, fig. 1.

1882. *C. parcus* Herrick (**23**), p. 229, pl. VI, figs. 12–15.
1884. " " " (**26**), p. 148, pl. R, fig. 22.

C. parcus, in the armature of the swimming feet is like *C. pulchellus* and *C. navus*, while its fifth feet are like those of *C. americanus* and *C. brevispinosus*, although the basal joint is somewhat narrower. My specimens agree with Herrick's description, except in the armature of the inner terminal segment of first feet, and his statement is evidently inaccurate, for no normal armature would be as he describes it.

C. parcus occurs in stagnant pools, and I have not found it common.

CYCLOPS LEUCKARTI Sars.

Plate IV, fig. 17; plate V, figs. 2–6.

1863. *C. leuckarti* Sars (**11**), p. 239.
1874. " *simplex* Poggenpol (**14**), p. 70, pl. XV, fig. 1–3.
1875. " *tenuicornis* Uljanin (**15**), p. 30, pl. IX, figs. 12 and 13.
1876. " *leeuwenhoekii* Hoek (**16**), p. 19, pl. III, figs. 1–12.
1880. " *simplex* Rehberg (**19**), p. 542.
1886. " " Vosseler (**28**), p. 193, pl. IV, figs. 15–17.
1887. " " Herrick (**30**), p. 17, pl. VII, fig. 1, a–j.
1891. " *leuckarti* Schmeil (**37**), p. 25.
1891. " *edax* Forbes (**35**), p. 709, pl. III, fig. 15; pl. IV, figs. 16–19.
1881. (*C. scourfeldi* Brady)? (**36**), p. 10, pl. IV, figs. 1–8.
1891. " *leuckarti* Richard (**39**), p. 230, pl. VI, fig. 20.
1892. " *leuckarti* Schmeil (**41**), p. 57, pl. III, figs. 1–8.

This species was particularly abundant in the collections from Lake Puckaway.

I have compared my specimens very carefully with the descriptions of the European form as given by Sars, Hoek and Schmeil, and the correspondence is almost perfect. The only difference seems to be that the lower side of the second joint of the outer maxilliped is ordinarily crenulated rather than "*geperlte.*" Specimens from Heart Lake, however, have more minute crenulations to which the term "*geperlte*" would be more properly applied. But in other points there is perfect agreement, noticeably so in the toothed appendage of the last antennal joint.

Schmeil states that the membrane of the last antennal segment of the female has a single deep indentation. My specimens have several, agreeing in this respect with the figure of Hoek.

It occurs in both day and evening collections, and is generally reddish in color.

This is one of the most widely distributed of all the species of *Cyclops*, being found in various parts of Europe, in Asia, Africa, Madagascar, Ceylon, and the East Indies (**34**). Herrick mentions it as occurring in Alabama (**30**), and it is probable that it is widely distributed in America. It seems to me probable that the species identified by Herrick as *oithonoides* (**26**, p. 150, pl. S, figs. 2–6), is really *leuckarti*.

Brady's *scourfeldi* corresponds to this species in all details except the armature of the terminal joint of the outer branch of the fourth foot. The special character by which he distinguishes the species,—the marginal setæ of the second maxillipedes,—I find in my specimens. In his figure of the fourth foot, the terminal joint of the outer branch has one spine and *two setæ* on the apex, instead of the normal armature of one spine and one seta. Schmeil's figure of the fourth foot (**41**, pl. III, fig. 6) shows an armature like that of the American specimens, and one cannot help thinking that Brady's figure must have been drawn from an abnormal specimen.

C. edax Forbes appears to differ from *leuckarti* only in that it lacks the ridge on the terminal joint of the antennæ, and is probably simply a less highly developed variety of the same species.

There is considerable variation in the form of the spines of the swimming feet; in some specimens they are very slender and the joints are at the same time somewhat elongated, while in other cases they are robust. The robust form appears to be characteristic of the littoral specimens, and the slender form of the pelagic.

The armature of the terminal joints of the swimming feet is as follows:

FIRST FOOT.

Outer br.	ex. 2 spines.		Inner br.	ex. 1 seta.
	ap. 2 setæ.			ap. 1 spine, 1 seta.
	in. 2 setæ.			in. 3 setæ.

SECOND AND THIRD FEET.

Outer br.	ex. 2 spines.	Inner br.	ex. 1 seta.
	ap. 1 spine, 1 seta.		ap. 1 spine, 1 seta.
	in. 3 setæ.		in. 3 setæ.

FOURTH FOOT.

Outer br.	ex. 2 spines.	Inner br.	ex. 1 seta.
	ap. 1 spine, 1 seta.		ap. 2 spines.
	in. 3 setæ.		in. 2 setæ.

CYCLOPS SIGNATUS Koch.

Plate V, figs. 7–9.

1820. *Monoculus quadricornis albidus* Jurine (**2**), pp. 44 and 47, pl. II, figs. 10–11; pl. III, fig. 24.

1820. *Monoculus quadricornis fuscus* Jurine (**2**), p. 47, pl. II, fig. 2.

1841. *C. signatus* Koch (**3**), H 21, pl. VIII.

1841. " *annulicornis* Koch (**3**). H 21, pl. VI.

1850. " *quadricornis* var. *b* Baird (**4**), p. 202, pl. XXIV, fig. 4.

1850. " " var. *c* Baird (**4**), p. 203, pl. XXIV, fig. 5.

1857. " *coronatus* Claus (**7**), p. 29, pl. II, figs. 1–11.

1857. " *tenuicornis* Claus (**7**), p. 31, pl. III, figs. 1–11.

1863. " *coronatus* Claus (**9**), p. 97, pl. II, fig. 16; pl. X, fig. 1.

1863. " *tenuicornis* Claus (**9**), p. 99, pl. I, fig. 3; pl. II, fig. 17; pl. IV, fig. 5.

1863. " *signatus* Sars (**11**), p. 242.

1863. " *annulicornis* Sars (**11**), p. 243.

1863. " *tenuicornis* Sars (**11**), p. 242.

1863. " *coronatus* Lubbock (**10**), p. 199.

1863. " *tenuicornis* Lubbock (**10**), p. 202.

1872. " *coronatus* Fric (**13**), p. 218, fig. 11.

1872. " *tenuicornis* Fric (**13**), p. 219, fig. 12.

1874. " *clausii* Poggenpol (**14**), p. 70, pl. XV, figs. 4–14.

1875. " *signatus* Uljanin (**15**), p. 29, pl. IX, figs. 6–11; pl. XI, fig. 8.

1876. " " Hoek (**16**), p. 12, pl. I. figs. 1-4.

1876. " *coronatus* Hoek (**16**), p. 12.

1878. *C signatus* Brady (**18**), p. 100, pl. XVII, figs. 4–12.
1876. " *tenuicornis* Brady (**18**), p. 102, pl. XVIII, figs. 1–10.
1883. " " Cragin (**24**), p. 3, pl. II, figs. 1–14.
1883. " *signatus* var. *fasciacornis* Cragin (**24**), p. 2, pl. II, fig. 15.
1884. " *tenuicornis* Herrick (**26**), p. 153, pl. R, fig. 16.
1885. " " Daday (**27**), p. 211.
1885. " *signatus* Daday (**27**), p. 208.
1886. " " Vosseler (**28**), p. 189, pl. IV, figs. 1–5.
1886. " *tenuicornis* Vosseler (**28**), p. 189, pl. IV, figs. 6–10.
1891. " *gyrinus* Forbes (**35**), p. 707, pl. II, fig. 9; pl. III, fig. 14.
1891. " *albidus* Schmeil (**37**), p. 23.
1891. " *signatus* Brady (**36**), p. 6, pl. 2, fig. 5.
1891. " *fuscus* Richard (**39**), p. 223, pl. II, fig. 6.
1891. " *annulicornis* and *tenuicornis* Richard (**39**), pp. 224–226.
1892. " *fuscus* Schmeil (**41**), p. 123, pl. I, figs. 1–7*b*; pl. IV, fig. 2.
1892. " *albidus* Schmeil (**41**), p. 128, pl. I, figs. 8–14*b*; pl. IV, fig. 14.

Brady considers *signatus* as the ultimate form of which *tenuicornis* is the penultimate. The serrated ridge on the last antennal joint must be considered, then, as not distinctive of the species, but of the ultimate stage of the species. With this opinion I am inclined to agree, although I have not material to demonstrate their identity. Schmeil (**41**) discusses the relations of the two forms in detail, and gives his reasons for believing them specifically distinct. In this same paper, however, he describes certain "bastard" forms which combine the characters of *signatus* and *tenuicornis*, and it would seem that the existence of such "bastards" would be a strong argument in favor of the identity of the forms.

C. signatus is a widely distributed species, being found in northern and western Europe, and in Great Britain, as well as in North America. It occurs in standing pools, but is more common in the lakes, being found in both pelagic and littoral collections.

CYCLOPS MODESTUS Herrick.

Plate V, figs. 10–13.

1883. *C. modestus* Herrick (**25**), p. 500.
1884. " " " (**26**), p. 154, pl. R, figs. 1–5.
1887. " " " (**30**), p. 14.

I have found *C. modestus* in only one locality,—Rush Lake. Herrick found it in Alabama and Minnesota. It appears to be a clearly marked species. The color in all my specimens was distinctly purplish, a color entirely different from that of the other entomostraca in the same collections. In all my specimens the antennæ were 16-jointed, and about as long as the first segment of the cephalothorax. The cephalothorax is oval and very broad as compared with the abdomen. The abdomen is slender. The furca is about as long as the last two abdominal segments, with the lateral spine situated about midway of its length. The external margin of the furca is hollowed out below the lateral spine. Of the terminal setæ, the first is small and spine like, the second about four-fifths the length of the third, and the fourth slightly shorter than the second.

The armature of the terminal joints of the swimming feet is as follows:

FIRST FOOT.

Outer br.	ex. 3 spines.	Inner br.	ex. 1 seta.
	ap. 1 spine, 1 seta.		ap. 2 spines, 1 minute seta.
	in. 3 setæ.		in. 2 setæ.

SECOND FOOT.

Outer br.	ex. 3 spines.	Inner br.	ex. 1 seta.
	ap. 1 spine, 1 seta.		ap. 2 spines.
	in. 4 setæ.		in. 1 spine, 2 setæ.

THIRD FOOT.

Outer br.	ex. 2 spines.	Inner br.	ex. 1 seta.
	ap. I spine, 1 seta.		ap. 2 spines.
	in. 4 setæ.		in. 1 spine-like seta, 2 setæ.

FOURTH FOOT.

Outer br.	ex. 2 spines.	Inner br.	ex. 1 seta.
	ap. 1 spine, 1 seta.		ap. 2 spines.
	in. 4 setæ.		in. 2 setæ.

The fifth foot is three-jointed, the second joint armed with a seta, and the third joint with two terminal setæ.

CYCLOPS FLUVIATILIS Herrick.

Plate V, figs. 14 and 15; plate VI, fig. 1.

1882. *C. fluviatilis* Herrick (**23**), p. 231, pl. VII, figs. 1–9.
1883. " *magnoctavus* Cragin (**24**), p. 5, pl. III, figs. 14–23.
1884. " *fluviatilis* Herrick (**26**), p. 159, pl. Q[5], figs. 1–9.
1887. " " " (**30**), p. 15.
1891. " *magnoctavus* Brady (**36**), p. 19, fig. 1-4.

I see no valid reason for separating *fluviatilis* and *magnoctavus*, although they are considered by Brady distinct species. *C. pentagonus* Vosseler is like *fluviatilis* in the form of the antennæ and abdomen, and in the armature of the feet. In the form of the cephalothorax it differs widely from *fluviatilis*, the first segment being short, broad and angular, while in *fluviatilis* the first segment is long and rounded, the whole cephalothorax being oval in outline. *C. fluviatilis* is not likely to be confounded with any other *Cyclops*, as we have only one other species with twelve-jointed antennæ,—*C. serrulatus*,—from which it is readily distinguished by its smaller size, and the different form of the abdomen and furca.

I have found *C. fluviatilis* only in pelagic collections. Cragin and Brady have found it in ditches. But Brady remarks: "It is curious that in both cases the animal was found in ditches immediately connected with large sheets of water."

Herrick says, "it is one of the most abundant forms in the larger lakes, and especially in streams."

CYCLOPS SERRULATUS Fischer.

Plate VI, figs. 2–5.

1838.	*C. agilis*	Koch (**3**), H 21, pl. III.
1851.	" *serrulatus*	Fischer (**5**), p. 423, pl. X, figs. 22, 26–31.
1853.	" "	Lilljeborg (**6**), p. 158, pl. XV, fig. 12.
1857.	" "	Claus (**7**), p. 36, figs. 1–3.
1863.	" "	Sars (**11**), p. 45.
1863.	" "	Claus (**9**), p. 101, pl. I, figs. 1 and 2; pl. IV, fig. 12; pl. XI, fig. 3.
1863.	" "	Lubbock (**10**), p. 197.
1870.	" "	Heller (**12**), p. 6.
1872.	" "	Fric (**13**), p. 222, fig. 18.
1875.	" "	Uljanin (**15**), p. 34, pl. VIII, figs. 1–8.
1878.	" "	Brady (**18**), p. 109, pl. XXII, figs. 1–14.
1880.	" *agilis*	Rehberg (**19**), p. 545.
1882.	" *serrulatus*	Herrick (**23**), p. 230.
1883.	" *pectinifer*	Cragin (**24**), p. 6, pl. IV, figs. 1–7.
1884.	" *serrulatus*	Herrick (**26**), p. 157, pl. O, figs. 17–19.
1885.	" *agilis*	Daday (**27**), p. 240.
1886.	" *agilis*	Vosseler (**28**), p. 190, pl. V, figs. 29–31.
1891.	" *serrulatus*	Schmeil (**37**), p. 29.
1891.	" "	Brady (**36**), p. 18, pl. VII, fig. 1.
1891.	" "	Richard (**39**), p. 234, pl. VI, fig. 19.
1892.	" "	Schmeil (**41**), p. 141, pl. V, figs. 6–12.

C. serrulatus is found everywhere. It is the most common of all the species of *Cyclops*. In the larger bodies of water it is more common in littoral collections, but it occurs not infrequently in pelagic collections.

This species has a wide limit of variation, the extreme forms differing so much that one is at first inclined to rank them as separate species. At one extreme is the form common in ditches, pools, and littoral collections, which seems to correspond nearly to *montanus* Brady. It averages .85 mm in length; the furca is not quite as long as the last two abdominal segments, and the external terminal seta is transformed into a stout spine three-fourths as long as the furca, projecting laterally from the body. At the other extreme is the pelagic form, *C. elegans* Herrick. It averages 1.25 mm in length. The furca is once and a third as long as the last two abdominal segments, and the external terminal seta is short and weak.

Sometimes the two forms occur together in pelagic collections, but only once have I found the *elegans* form as a littoral species. The European form is, in its characteristics, intermediate between these extreme forms.

Although the extreme varieties sometimes occur together, they are almost always entirely distinct. In only two localities have I found connecting forms. In Heart Lake I found an intermediate form associated with the smaller variety, and in Lake Puckaway I found the typical form in connection with both extremes.

CYCLOPS PHALERATUS Koch.

Plate VI, figs. 6 and 7.

1841.	*C. phaleratus*		Koch (**3**), H 21, pl. IX.
1851.	" *canthocarpoides*		Fischer (**5**), p. 246, pl. X, figs. 24, 32–38.
1853.	"	"	Lilljeborg (**6**), p. 208.
1857.	"	"	Claus (**7**), p. 37, pl, I, figs. 6–10.
1863.	"	"	" (**9**), p. 102, pl. IV, figs. 1–4.
1863.	"	"	Lubbock (**10**), p. 202.
1863.	" *phaleratus*		Sars (**11**), p. 46.
1872.	" *canthocarpoides*		Fric (**13**), p. 223, fig. 19.
1874.	" *lascivus*		Poggenpol (**14**), p. 72, pl. XV, figs. 22–24; pl. XVI, figs. 7 and 8.
1875.	" *phaleratus*		Uljanin (**15**), p. 38, pl. IX, figs. 1–5.
1878.	"	"	Brady (**18**), p. 116, pl. XXIII, figs. 7–13.
1882.	" *adolescens*		Herrick (**23**), p. 231, pl. VI, figs. 16–20.
1883.	" *perarmatus*		Cragin (**24**), p. 7, pl. I, figs. 9–18.
1884.	" *phaleratus*		Herrick (**26**), p. 161, pl. R, figs. 6–10.
1885.	"	"	Daday (**27**), p. 252.
1887.	"	"	Herrick (**30**), p. 14, pl. VII, fig. 2, a–d.
1891.	"	"	Schmeil (**37**), p. 36.

1891. *C. phaleratus*, Brady (**36**), p. 25, pl. IX, fig. 2.
1891. " " Richard (**39**), p. 238, pl. VI, fig. 12.
1892. " " Schmeil (**41**), p. 170, pl. VIII, figs. 1–2.

The European *C. phaleratus* has ten-jointed antennæ. Our specimens ordinarily have eleven joints, although sometimes, according to Herrick, occurring with ten. In other respects, my specimens agree with those figured by European authors even in minute details, and there seems no good reason for making a new species of our form.

It occurs quite widely distributed in the smaller lakes, and in stagnant pools.

CYCLOPS BICOLOR Sars.

1863. *C. bicolor* Sars (**11**), p. 253.
1880. " *diaphanus* Rehberg (**19**), p. 547.
1884. " " Herrick (**26**), p. 160, pl. R, fig. 12.
1885. " " Daday (**27**), p. 246.
1887. " " Herrick (**30**), p. 16, pl. VII, figs. 3a–e.
1891. " *bicolor* Schmeil (**37**), p. 34.
1891. " *diaphanus* Richard (**39**), p. 236, pl. VI, fig. 26.
1892. " *bicolor* Schmeil (**41**), p. 118, pl. VI, figs. 6–13.

The antennæ are 11-jointed, hardly as long as the first cephalothoracic segment. The abdomen is somewhat elongated, the last segment armed with spines posteriorly. The furca is nearly as long as the last two abdominal segments. The lateral spine is situated at about the posterior third. The first and fourth terminal setæ are short, the inner considerably longer than the outer. The median setæ are strongly plumose, and the longer is about as long as the abdomen.

The rami of the swimming feet are two-jointed. The armature of the terminal joints is as follows:

FIRST FOOT.

Outer br.	ex. 3 spines.	Inner br.	ex. 1 seta.
	ap. 2 setæ.		ap. 1 seta, 1 large spine.
	in. 3 setæ.		in. 3 setæ.

SECOND AND THIRD FEET.

Outer br.	ex.	3 spines.	Inner br.	ex.	1 seta.
	ap.	1 spine, 1 seta.		ap.	1 spine, 1 seta.
	in.	4 setæ.		in.	4 setæ.

FOURTH FEET.

Outer br.	ex.	2 spines.	Inner br.	ex.	1 seta.
	ap.	1 spine, 1 seta.		ap.	2 spines.
	in.	4 setæ.		in.	3 setæ.

The last cephalothoracic segment is expanded laterally, and bears upon each side a long seta. The fifth feet are attached to these expansions, are one-jointed, linear, and each bears at the tip a single seta.

Females average a little more than ½ mm. in length. The color in all the specimens I have seen has been purplish. My specimens agree very well with the descriptions of Sars and Schmeil, the only marked difference being in the length of the caudal setæ. More complete descriptions of the European form may show other differences, but so far as the descriptions go, they apply very well to our form.

C. bicolor occurs in stagnant pools, and is somewhat rare.

CYCLOPS FIMBRIATUS Fischer.

Plate VI, figs. 8 and 9.

1785. *C. crassicornis* Mueller (**1**), p. 113, pl. XVIII, figs. 15–17.
1853. " *fimbriatus* Fischer (**5**), p. 94, pl. III, figs. 19–28 and 30.
1863. " *crassicornis* Sars (**11**), p. 47.
1870. " *gredleri* Heller (**12**), p. 8, pl. 1, figs. 3 and 4.
1872. " *pauper* Fric (**13**), p. 223, fig. 20.
1875. " *crassicornis* Uljanin (**15**), p. 39, pl. VIII, figs. 9–16; pl. XII, fig. 1.
1878. " " Brady (**18**), p. 118, pl. XXIII, figs. 1–6.
1880. " *poppei* Rehberg (**19**), p. 550, pl. VI, figs. 9–11.
1880. " *fimbriatus* Rehberg (**19**), p. 548, pl. VI, figs. 7 and 8.
1882. " *crassicornis* Herrick (**23**), p. 232, pl. IV, figs. 9–14.

1884. *C fimbriatus* Herrick (**26**), p. 162, pl. R, fig. 11.
1885. " " Daday (**27**), p. 262.
1885. " *margoi* Daday (**27**), p. 264, pl. III, figs. 20–25.
1886. " *fimbriatus* Vosseler (**28**), p. 192, pl. VI, figs. 4–8.
1891. " " Schmeil (**37**), p. 35.
1891. " " Brady (**36**), p. 25, pl. IX, fig. 1.
1891. " " Richard (**39**), p. 238, pl. VII, figs. 13 and 14.
1892. " " Schmeil (**41**), p. 161, pl. VII, figs. 8–13.

This, our only eight-jointed species, I have found in only two localities. It corresponds quite exactly wlth the descriptions of the European authors. Brady, however, in fig. 4, pl. XXIII of his monograph, represents the terminal joint of the inner ramus of the second foot as armed with a *spine* on the inner margin. In my specimens this joint has a *seta* on the inner margin. But making allowance for possible inaccuracies in the figure, I see no reason for doubting the identity of the forms.

Herrick states that the color is always reddish. I have found nearly colorless individuals, and I think that the color of this, as of other species, varies according to the environment.

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EXPLANATION OF PLATES.

PLATE III.

Fig. 1. *Diaptomus sanguineus*—terminal joints of male antenna x 163.
2. " " fifth feet of male x 163.
3. " " fifth foot of female x 163.
4. " *leptopus*—fifth foot of female x 163.
5. " " fifth feet of male x 163.
6. " *pallidus*—fifth feet of male x 300.
7. " " fifth foot of female x 300.
8. " *sicilis*—fifth feet of male x 163.
9. " *pallidus*—abdomen of female x 300.
10. " *sicilis*—fifth foot of female x 300.
11. " *ashlandi*—fifth feet of male x 163.
12. " " fifth foot of female x 163.
13. " " terminal joints of male antenna x 300.

PLATE IV.

Fig. 1. *Diaptomus minutus*—fifth feet of male x 163.
2. " " fifth foot of female x 300.
3. " " terminal joints of male antenna x 300.
4. " *oregonensis*—fifth feet of male x 163.
5. " " fifth foot of female x 300.
6. *Epischura lacustris*—abdomen of male x 92.
7. *Limnocalanus macrurus*—abdomen of male x 40.
8. *Cyclops americanus*—abdomen of female x 58.
9. " " fourth feet x 163.
10. " " fifth foot x 300.
11. " *brevispinosus*—furca x 163.
12. " " fourth foot x 163.
13. " *navus*—abdomen of female x 68.
14. " " fourth foot x 163.
15. " " fifth foot x 300.

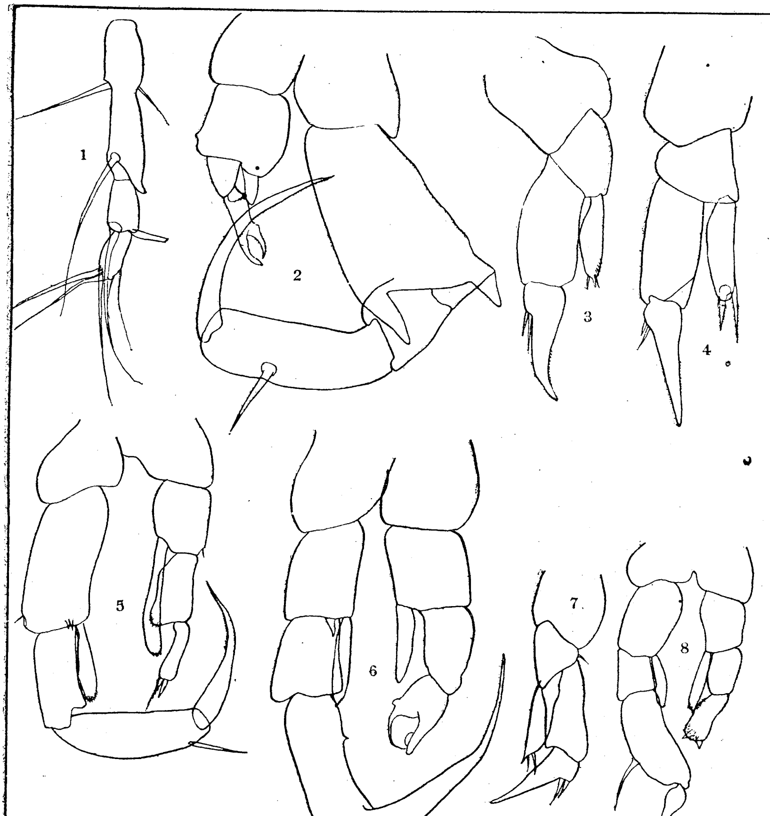
16. *Cyclops parcus*—fifth foot x 300.
17. " *leuckarti* from Heart Lake — second joint of outer maxilliped x 163.
18. " *pulchellus*—fifth foot x 300.
19. " " abdomen of female x 163.

PLATE V.

Fig. 1. *Cyclops parcus*—fourth foot x 163.
2. " *leuckarti*—fifth foot x 300.
3. " " last antennal joint of female x 300.
4. " " from Lake Gussie — outer maxilliped x 300.
5. " " abdomen of female x 58.
6. " " littoral variety—fourth foot x 163.
7. " *signatus*—fourth foot x 163.
8. " " fifth foot x 300.
9. " " last antennal joint of female x 300.
10. " *modestus*—fourth foot x 195.
11. " " furca x 163.
12. " " fifth foot x 360.
13. " " outer terminal joint of third foot x 300.
14. " *fluviatilis*—fifth foot x 360.
15. " " fourth foot x 300.

PLATE VI.

Fig. 1. *Cyclops fluviatilis*—abdomen of female x 300.
2. " *serrulatus*—abdomen of female, extreme pelagic form, x 75.
3. " " abdomen of female, intermediate form, x 100.
4. " " abdomen of female, littoral form, x 178.
5. " " fourth foot x 178.
6. " *phaleratus*—abdomen of female x 92.
7. " " second antenna x 300.
8. " *fimbriatus*—fourth foot x 300.
9. " furca x 300.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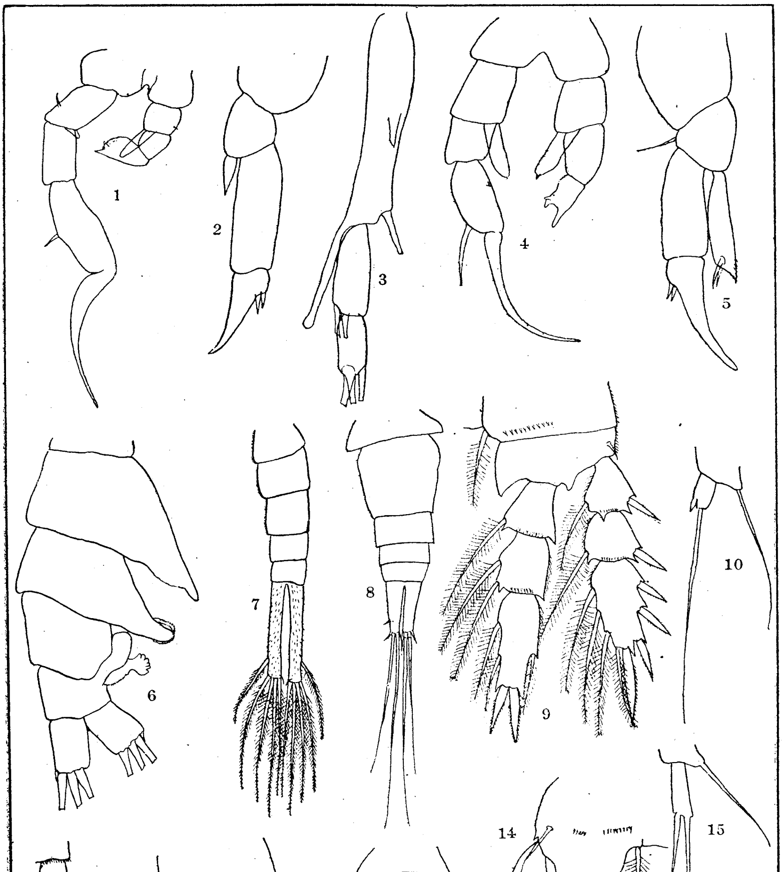
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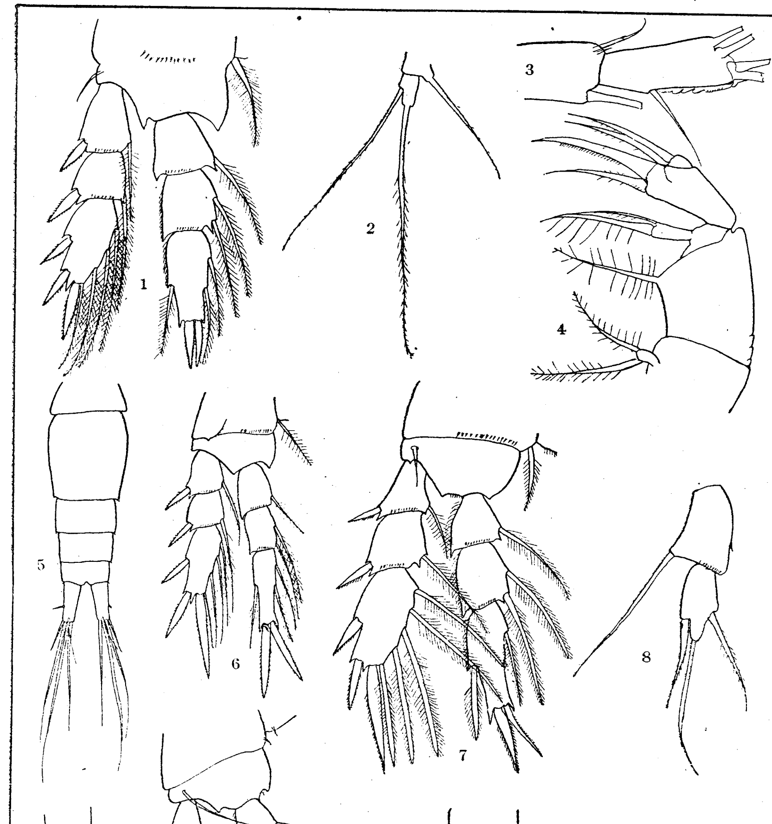
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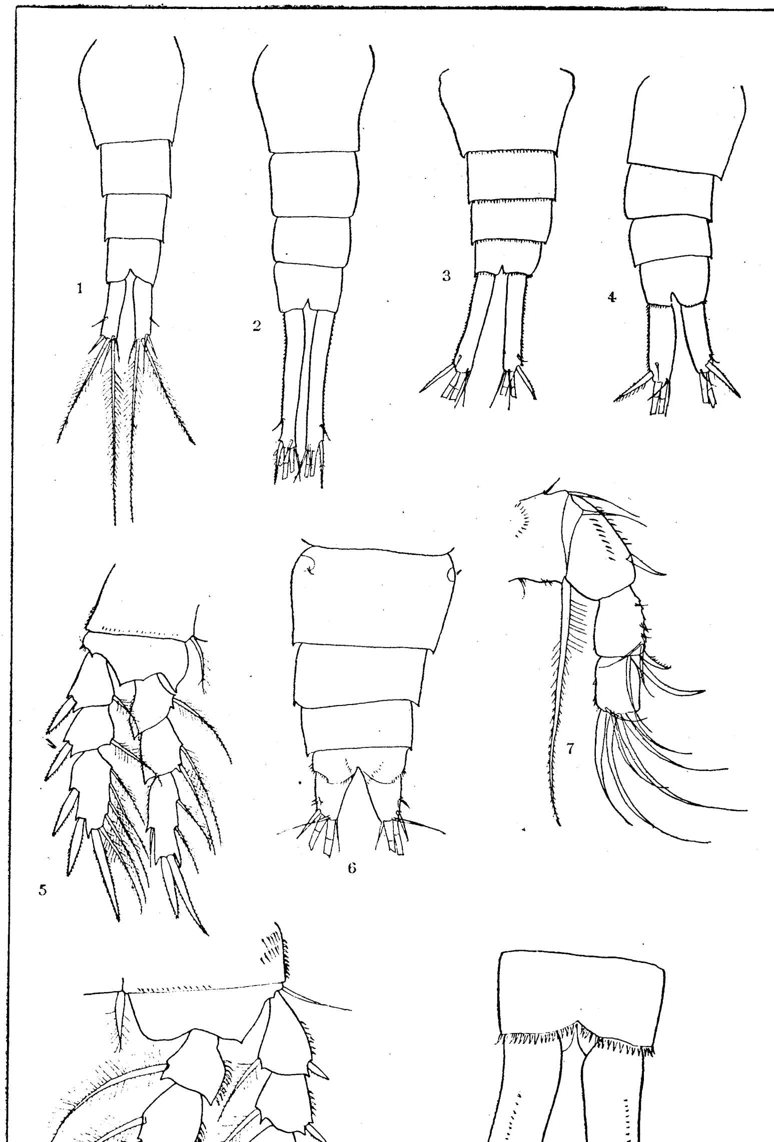
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THE PROGRESS OF GEOLOGICAL SURVEYS IN THE STATE OF WISCONSIN—A REVIEW AND BIBLIOGRAPHY.

BY WILLIAM P. BLAKE, NEW HAVEN, CT., AND SHULLSBURG, WIS.

[ABSTRACT.]

The memoir gives an historical account and review of the early settlement of the lead region, and of the surveys undertaken by the general government. One of the chief objects is to show the opinions held by Percival and his successors upon the subject of the origin of the lead and zinc ores, and the relation of the deposits of such ores to breaks in the strata, and a portion of this part of the paper is now presented.

The poet and geologist, James G. Percival, after the completion of his part of the work on the survey of the state of Connecticut, was employed by the American Mining Company of New York to make examination and surveys of their mines in Wisconsin. He was so engaged during the year 1853, and the next year was appointed the geologist of the state, receiving his commission from Governor Wm. A. Barstow, on the 12th of August, 1854.

His instructions were to examine the mineral district in the southwest counties of the state. His first report was printed in Madison in 1855.* In this he confines his descriptions chiefly to the result of his own observations, and the volume is characterized by the minute and careful attention to every detail, and accuracy of observation and description for which his work will ever be notable. The report is accompanied by one map delineating the extent of the lead region and the di-

* Annual Report on the Geological Survey of the State of Wisconsin. By James G. Percival. Small 8vo. pp. 101 with Map. Madison, 1855.

rection of the deposits, upon a scale of one-fourth of an inch to the mile, but exhibiting the relative number and the direction of the known ore-bearing crevices by means of small lines, the first attempt, perhaps, to represent the surface arrangement of the diggings, and the general direction of the bodies of ore.

In addition to the descriptions in detail of the various formations and of the veins or deposits of the ores of lead and zinc, he notes particularly, under a general dip of the strata to the south, local inequalities in the stratification at various points, indicative of extraordinary elevations of the strata and the existence of faults or breaks in the formations. Five at least of such faults are described in the region of the Pecatonica valley, of Fever river, of the Platte and on Grant river.

In regard to the extent downwards of the mineral deposits, he favored the view of many that the viens could be traced, with some interruption, from the Upper Magnesian Limestone downwards to and into the Lower Magnesian. On p. 67 he says:—"I have not yet had time to explore the country occupied by the Lower Magnesian to any extent, and have visited no other digging in that rock but those in the vicinity of Blue river, known as Oleking's Diggings. These, however, furnish most satisfactory evidence that the mineral occurs in that rock at the proper openings in as large masses and arranged as regularly as in the Upper Magnesian." * * "After examining this locality, I could not doubt that the Lower Magnesian is a good mineral-bearing rock. I have thus been able to trace the mineral in a series of crevices and openings from the summit of the Upper Magnesian to the depth of 60–70 feet in the Lower Magnesian, and have found all the different beds of limestone good mineral-bearing rocks, each with one or more openings, besides vertical or pitching sheets or veins." He notes that the arrangement appears to be analagous to that of the lead mines in the north of England where the veins traverse different beds of limestone separated by other beds, the mineralization being confined chiefly to the limestone.

In regard to the arrangement or distribution of the deposits, their grouping and direction, he was convinced that there is a systematic order pervading the whole district, indicating that the mineral deposits are not casual but regularly rrranged, and parts of a connected whole (p. 91); and again in his summing up at the end of his report, he reiterates: "The leading object of the detail which I have given of the arrangement of the mineral in the crevices and openings, in its distribution through the different strata from above downwards, and of the surface arrangement in groups and in more extended combinations, has been to show that a systematic order prevails throughout, and that the mineral deposits are not detached and casual, but combined in regular series" (p. 98). Also: "The traces of order and connexion in the surface arrangement appear no less remarkable than in the vertical arrangement. What I have here given is only a small part of what might have been stated; but I trust it will suffice to show that the ranges in their bearing and in their grouping from the smallest to the most extended combinations have been governed by some general laws, and have not been merely local accidents." (p. 101.)

A second but posthumous report from this gifted man appeared in 1856.* While Dr. Percival was engaged in its preparation, he was stricken down and died on the second day of May, 1856. His manuscript was unfinished, but was carefully copied and finished for the press. It was addressed to Governor Coles Bashford, and reported the results of a trip he had made to the northern regions of the state during which he visited thirty-eight out of fifty counties. As a general result he stated that he was still "more strongly persuaded of the probability of [success] of continued deep mining," and adds that "the opinion expressed in my former report that the mineral was derived from beneath is strengthened not only by the general results of my observations in the diggings, but by the appearance of disturbance in the strata, particularly along the line of the great body of mineral traversing the middle of the district, and by the relation in the bearing of that body to the extensive ranges of primary and metamorphic rocks towards the northeast, indicating that the mineral may have arisen

***[Second] Annual Report on the Geological Survey of the State of Wisconsin. pp. 111. Madison, 1856.**

from a mass of such rocks beneath the secondary strata." (p. 63.)

It is singular that Dr. Percival did not notice the absence of the northern or glacial drift over the area of the lead rogion.

In Percival's day the zinc ores had not been utilized, but he directed attention to their value for making not only spelter, but zinc oxide for paint,* and I am told that he was the first to induce the miners to make shipments of Smithsonite, "dry bone," to the New Jersey Zine company at Newark. He thus hastened the utilization of the "dry-bone," but Owen had already directed attention to its value.

After the death of Percival and the reorganization of a survey of the state under the direction of Prof. Jas. Hall, Prof. J. D. Whitney was selected to examine and report upon the lead region.

Prof. Whitney at once recognized that the foremost unanswered question in the minds of both the miners in the lead region and those who had written about the mineral deposits, was whether deep mining was likely to be productive; whether by sinking through the blue limestone [the Trenton Limestone] and other beds in the Lower Magnesian Limestone, new sources of ore might be found along the possible extension downwards of the crevices of the upper beds. This question, we may say, has not even yet been answered by actual trial, although it has been answered theoretically by Whitney and others in the negative. We have seen that Percival gave the subject much attention, and that the direction of his labors was toward solving the problem of the origin of the system of lead-bearing crevices, and of their relations to, or dependence for, their origin upon the faults, dislocations and breaks of the strata.

Professor Whitney gave especial attention to this subject, and felt obliged to state that he differed *in toto* with Dr. Percival "in the general conclusions which he drew from his observations, especially in regard to the feasibility of deep mining in the lead region, the most important point, practically, to those interested in that district."† In the concluding pages of

*First Report, p. 98.

† Vol. I, Hall & Whitney's Report, p. 84.

his report the subject is fully discussed, and a resume of his conclusions is given as follows:*

1st. Each mining district in the lead region has its metalliferous deposits confined to a certain vertical range, which does not in any one locality or group of diggings extend through the whole series of lead-bearing strata.

2d. The mineral deposits do not extend into the upper sandstone, and the cracks or joints in that rock are not continuous with or dependent on those in the groups above or below.

3d. The Lower Magnesian Limestone has nowhere been proved to be a rock which can be mined in profitably for lead for any length of time.

It should be noted that Whitney did not discuss the cause of the linear distribution of the mineral-bearing crevices; their origin and relation to the lines of uplift which had so greatly impressed Percival, nor did he find any faults in the strata, which Percival had so specifically noted and described, Whitney's statements relative to these subjects being: "There is no evidence in the lead region of the deposits of ore or the crevices being situated over or near faults or dislocations of the surface, or of being in any way connected with subterranean or deep-seated movements of the crust of the earth, such as would allow of the metalliferous solutions having access from below." (Page 393.) This is remarkable, inasmuch as dislocations do exist as Percival stated, and that they do certainly appear to have some relation to the mineral deposits, a relation which needs investigation.

Professor Whitney's report is well illustrated by drawings of the various forms of crevices, openings, chambers and deposits of ore. Many of these illustrations, with a memoir upon the Lead Deposits of the Mississippi Valley, were published in the Mining Magazine.†

Professor Whitney did not fail to note and to fully discuss the phenomenon of the absence of drift deposits within the limits of the productive lead region, and gives a diagram or small map upon which the boundaries of the region destitute of drift are shown.‡ The conclusions to which a study of this

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* Vol. I, Hall & Whitney's Report, p. 416.

‡ Mining Magazine and Journal of Geology.

† Report 1862, Fig. 2, pp. 118-119.

driftless region led him were, briefly stated, that the region existed as an island rising above the level of the ocean during the drift epoch, and consequently escaped the deposition of drift boulders and other materials characterizing the drift deposit of adjoining regions. In forming this conclusion it will be noted that he held the then prevalent opinion of the diluvial origin of drift deposits, and that he did not entertain the idea of their glacial origin and distribution. He carefully and correctly describes the phenomena of chemical erosion or gradual solution of the surface of the rocks and the accumulation on the surface of the less soluble portions, such as flint nodules and fragments, remarking that we never find them assorted in layers, or showing any indication of the action of currents of water, from which he concludes that the driftless region must have formed an island at the time "when the great currents from the north were bringing down the detrital materials which were spread over so vast an area in the northern hemisphere."*

He directs attention to the fact that in the lead region the line of water-shed is an exact east and west one, and that it is pretty evident "that this portion of the surface of the state has been elevated parallel to the great north and south axis which has determined the geological features." (P. 127.)

Professor Whitney formulated a theory of the original deposition of the ores from the waters of the ocean in certain areas determined by the presence of marine plants.

However probable this may be, it fails to explain the sharply defined linear distribution of the ores, and the origin of what we may term the vein system.

Professor Chamberlin's theory of undulations as opposed to faulting, if accepted, leads us substantially to the conclusion that the distribution of the ores is due to the structure, or rather to the *disturbance* of the strata. This implies that the deposits really have the nature of lodes, and that the same causes may produce like effects in all of the beds whose chemical composition is favorable to the deposition of ores. It is, therefore favorable to the view that ore deposits may be found in te

* Report 1862, p. 123.

Lower Magnesian Limestone, as contended for by Percival and many others.

The paucity of close observations in the field should for the present leave theorizing to the future. Had Percival lived a few years longer, this want would undoubtedly have been supplied. My own knowledge of the lead and zinc deposits leads me to believe Percival's view is the correct one, and that the lead-bearing regions are extensively faulted and broken, and that the ore deposits have a direct and close relation to the faults.

A CONTRIBUTION TO THE FLORA OF THE LAKE SUPERIOR REGION.

BY L. S. CHENEY.

During the summer of 1891, through the kindness of Mr. F. F. Wood, I had the pleasure of doing some collecting at various points in northern Wisconsin, along the north shore of Lake Superior, and along the boundary between Minnesota and Ontario,—the last a region comparatively little known, botanically. It is with the permission of Mr. Wood that I make use of the material obtained at that time, in this brief paper.

Excluding the small portion in Wisconsin, the region under consideration is a heavily timbered one, made up in greater part of a series of parallel ridges running east and west, and separated by deep narrow lakes, or tamarack or cedar swamps. Geologically, the rocks of the region belong to the Algonkian age. Along the course of the Pigeon river and boundary to Gunflint Lake, the Huronian appears. Between Gunflint Lake and Lake Seiganagah the Archæan breaks through, giving the name Granite River to the short stream connecting the two bodies of water.

From Lake Seiganagah west to Tower, the Huronian is again the surface formation. To the southwest of Gunflint Lake, the Archæan again appears as a long narrow ridge running away a hundred or more miles to the southwest. This ridge is known as the Mesabe range. Adjoining this range on the south is another narrow strip of Huronian. Over the remainder of the region, the Keweenawan forms the surface formation.

Collecting was done at Fond du Lac, on the St. Louis river; along the lake shore from Grand Marais to Grand Portage; along the old Dawson Canoe route (a line almost identical with the boundary between Minnesota and Ontario) from Grand Portage to Basswood Lake; from this lake, along the canoe route commonly travelled, to Ely and Tower; and in the vicinity of Barron, Wisconsin. The work was begun June 16th, at Fond du Lac. We were detained ten days at Grand Marais, awaiting the construction of a canoe. At Rove Lake we were obliged to wait four days for provisions. With these two exceptions, we never stopped longer than thirty-six hours at a place. We generally travelled ten to twelve miles each day, collecting on the way. We reached Tower August 3d, and went from there to Barron, where collecting was done a few days longer.

The list of plants appended include four new to the region covered by Gray's Manual (last edition). Of these *Ribes Hudsonianum* has not, I think, been previously reported from farther east than Montana; *Carex obesa* var. *minor*[1] has not been found before south of the Saskatchewan. *Ranunculus Lapponicus*[2] is new to the United States. *Deplophyllum Dicksoni* is the fourth. The distribution of an introduced plant, *Ranunculus acris*, seems worthy of special mention. It was observed at all old fishing stations along Lake Superior. At Grand Portage it literally covered the land occupied by the village, and also the adjoining fields,—perhaps fifteen acres in all. From this village the plant has been carried westward along the canoe route to the portage between North Lake and South Lake, a distance of sixty miles. It was observed at most of the portages between the two points, usually at the landings. This distribution was evidently effected either by travellers carrying the flowers or seed, intentionally or otherwise, or by the seed adhering to the hair of dogs or other animals. A similar distribution from the village may be looked for along other trails, or canoe routes.

No attempt was made to collect specimens of the larger shrubs or trees; or in most cases, other plants known or supposed to be widely distributed. Such of these, however, as were identified have been inserted in the list. I desire to ac-

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[1] See "Notes on Carex." L. H. Bailey, Bot. Gaz., Vol XVII, No. 5.

[2] See "New and Noteworthy North American Plants." John M. Coulter and Elmon M. Fisher. Bot. Gaz., Vol. XVII, No 8.

knowledge my obligations to Dr. L. M. Underwood, of De Pauw University; Dr. J. M. Coulter, of Lake Forest University; Dr. L. H. Bailey, of Cornell University; Dr. C. R. Barnes, of the University of Wisconsin; and Mr. R. H. True, formerly of the University of Wisconsin, for aid kindly rendered.

1. *Anemone nemorosa*, L.
   Grand Marais.
2. *Coptis trifolia*, Salisb.
   Grand Marais.
3. *Ranunculus acris*, L.
   At all old fishing stations along the north shore of Lake Superior and on most of the portages along the boundary between Canada and Minnesota west to North Lake.
4. *Ranunculus aqualitis*, L., var. *trichophyllus*, Gray.
   Granite River.
5. *Ranunculus Flammula*, L., var. *reptans*, E. Mayer.
   Partridge Falls.
6. *Ranunculus hispidus*, Hook.
   Devil's Track River.
7. *Ranunculus Lapponicus*, L.
   On the Duluth and Port Arthur trail, three miles west of Mawshequawcawmaw River.
8. *Ranunculus Pennsylvanicus*, L. f.
   Granite River, one and a half miles below Gunflint Lake.
9. *Nuphar advena*, Ait. f.
   Rove Lake.
10. *Nuphar Kalmianum*, Ait.
    Daniels Lake and Basswood Lake.
11. *Nymphœa odorata*, Ait.
    Gunflint Lake.
12. *Nymphœa odorata*, Ait., var. *minor*, Sims.
    Small lake on portage between Moose Lake and Mountain Lake.
13. *Corydalis aurea*, Willd.
    Grand Marais.

14. *Corydalis glauca*, Pursh.
    Grand Marais and Devil's Track River.
15. *Arabis lyrata*, L.
    Grand Portage.
16. *Barbarea vulgaris*, R. Br.
    Grand Marais.
17. *Cardamine hirsuta*, L.
    Grand Marais.
18. *Sisybrium canescens*, Nutt.
    Grand Marais.
19. *Viola rotundifolia*, Michx.
    Fond du Lac.
20. *Elodes campanulata*, Pursh.
    Portage between Mud Lake and Rat Lake.
21. *Tilia Americana*, L.
    Fond du Lac.
22. *Oxalis Acetosella*, L.
    Grand Marais.
23. *Acer saccharinum*, Wang.
    Fond du Lac and Basswood Lake.
24. *Acer spicatum*, Lam.
    Portage at east end of Sucker Lake.
25. *Rhus glabra*, L.
    Northern outlet of Lake Seiganagah.
26. *Lathyrus maritimus*, Bigelow.
    North shore of Lake Superior, at Scott's Creek.
27. *Lathyrus venosus*, Muhl.
    On portage from Pigeon River to South Fowl Lake.
28. *Geum rivale*, L.
    Portage between North Fowl Lake and Moose Lake.
29. *Potentilla fruticosa*, L.
    Grand Marais, and on many rocky points along the north shore of Lake Superior.
30. *Potentilla tridentata*, Ait.
    Usually found with the preceding.
31. *Prunus pumila*, L.
    Island at east end of Lake Seiganagah.
32. *Prunus serotina*, Ehrh.
    Fond du Lac and Grand Marais.

33. *Prunus Virginiana*, L.
    Grand Marais.
34. *Rubus Nutkanus*, Mocino.
    Fond du Lac, Grand Marais, and portage at east end of Sucker Lake.
35. *Rubus occidentalis*, L.
    Fond du Lac.
36. *Rubus strigosus*, Michx.
    Common on all clearings and burnt districts.
37. *Rubus villosus*, Ait.
    Fond du Lac.
38. *Saxifraga Aizoon*, Jacq.
    South Fowl Lake.
39. *Mitella nuda*, L.
    Fond du Lac and Grand Marais.
40. *Heuchera hispida*, Pursh.
    Grand Marais.
41. *Ribes Cynosbati*, L.
    Grand Marais.
42. *Ribes lacustre*, Poir.
    Grand Marais.
43. *Ribes prostratum*, L'Her.
    Grand Marais.
44. *Ribes Hudsonianum*, Richards.
    Grand Marais.
45. *Ribes rubrum*, L., var. *subglandulosum*, Maxim.
    Grand Marais.
46. *Drosera rotundifolia*, L.
    Barron, Mountain Lake and Burntside Lake.
47. *Drosera intermedia*, Hayne, var. *Americana*, DC.
    Barron.
48. *Hippuris vulgaris*, L.
    Grand Marais.
49. *Epilobium angustifolium*, L.
    Abundant everywhere on burnt lands.
50. *Œnothera biennis*, L.
    West of Brule River.
51. *Œnothera pumila*, L.
    Granite River and Oshkosh Lake.

52. *Circæa alpina*, L.
Partridge Falls, Pigeon River.

53. *Aralia hispida*, Vent.
Red Rock, north shore of Lake Superior, and west end of portage between Rove Lake and Mud Lake.

54. *Cornus Canadensis*, L.
Fond du Lac, Grand Marais, Grand Portage, and Granite River.

55. *Sambucus racemosa*, L.
Fond du Lac and Grand Marais.

56. *Viburnum pauciflorum*, Pylaie.
Grand Marais and near Brule River.

57. *Linnæa borealis*, Gronov.
Common and abundant.

58. *Lonicera hirsuta*, Eaton.
On the portage between Grand Portage and Pigeon River.

59. *Aster macrophyllus*, L.
Fond du Lac, Grand Marais, Grand Portage, Granite River and Basswood Lake.

60. *Erigeron Philadelphicus*, L.
Portage between Pigeon River and South Fowl Lake.

61. *Antennaria plantaginifolia*, Hook.
Grand Marais.

62. *Anaphalis margaritacea*, Benth. & Hook.
Eastern extremity of Hunter's Island and Grand Marais.

63. *Lobelia Dortmanna*, L.
Rove Lake.

64. *Vaccinium Canadense*, Kalm.
Grand Marais, Granite River, and Gunflint Lake.

65. *Vaccinium uliginosum*, L.
On rocks north shore of Lake Superior ten miles west of Grand Portage.

66. *Vaccinium Vitis-Idæa*, L.
Grand Marais.

67. *Vaccinium Oxycoccus*, L.
Grand Marais.

68. *Arctostaphylos Uva-ursi*, Spreng.
Grand Marais. Along the lake shore at Red Rock.

69. *Andromeda polifolia*, L.
Grand Marais.

70. *Kalmia glauca*, Ait.
Grand Marais.

71. *Chimaphila umbellata*, Nutt.
Granite River, and on an island at the east end of Lake Seiganagah.

72. *Moneses grandiflora*, Salisb.
Fond du Lac, Grand Marais, and Rove Lake.

73. *Pyrola minor*, L.
South Fowl Lake.

74. *Pyrola secunda*, L.
Rove Lake.

75. *Pyrola chlorantha*, Swartz.
Pigeon River near Partridge Falls.

76. *Pyrola elliptica*, Nutt.
Portage between Mud Lake and Rat Lake.

77. *Pyrola rotundifolia*, L., var. *incarnata*, DC.
Partridge Falls on Pigeon River.

78. *Primula Mistassinica*, Michx.
Grand Marais.

79. *Trientalis Americana*, Pursh.
Grand Marais.

80. *Steironema ciliatum*, Raf.
Island at the east end of Lake Seiganagah.

81. *Lysimachia stricta*, Ait.
Mud Lake, Cook County.

82. *Halenia deflexa*, Grisebach.
Grand Marais.

83. *Phacelia Franklinii*, Gray.
Thompsonite Bay, six miles west of Grand Marais.

84. *Mertensia paniculata*, Don.
Fond du Lac.

85. *Physalis grandiflora*, Hook.
Ely.

86. *Mimulus ringens*, L.
Portage between North Lake and Gunflint Lake.

87. *Castilleia pallida*, Kunth., var. *septentrionalis*, Gray.
North shore of Lake Superior, five miles west of Grand Portage.

88. *Euphrasia officinalis*, L., var. *Tatarica*, Benth.
Grand Marais.

89. *Melampyrum Americanum*, Michx.
North shore of Lake Superior, five miles west of Grand Portage.

90. *Utricularia vulgaris*, L.
Granite River.

91. *Pinguicula vulgaris*, L.
At Grand Marais and other places on rocks along the lake shore east to Grand Portage.

92. *Lycopus sinuatus*, Ell.

93. *Calamintha Clinopodium*, Benth.
Portage between Lake Seiganagah and Oshkosh Lake.

94. *Lophanthus anisatus*, Benth.
Portage between Burntside Lake and Mud Lake.

95. *Scutellaria lateriflora*, L.
On an Island at the west end of Lake Seiganagah.

96. *Scutellaria galericulata*, L.
With *S. lateriflora*.

97. *Brunella vulgaris*, L.
Grand Portage and Tower.

98. *Plantago major*, L.
At the mouth of Devil's Track River.

99. *Polygonum tenue*, Michx.
At Grand Marais and Devil's Track River.

100. *Polygonum amphibium*, L.
Granite River and Basswood Lake.

101. *Polygonum viviparum*, L.
Grand Marais.

102. *Asarum Canadense*, L.
Fond du Lac and Grand Marais.

103. *Ulmus Americana*, L.
Fond du Lac, Grand Marais, and occasional along the boundary between Minnesota and Ontario.

104. *Myrica asplenifolia*, Endl.
Large island in the west end of Lake Seiganagah

105. *Betula lenta*, L.
Common throughout the region.

106. *Betula papyrifera*, Marshall.
Common and more abundant than *B. lenta*.

107. *Betula pumila*, L.
Borders of lakes along the boundary between Minnesota and Ontario.

108. *Betula glandulosa*, Michx.
Rat Lake.

109. *Alnus viridis*, DC.
Grand Marais, Scott's Creek and Brule River.

110. *Alnus incana*, Willd.
Grand Marais.

111. *Corylus Americana*, Walt.
Fond du Lac. Grand Portage.

112. *Corylus rostrata*, Ait.
Fond du Lac, Grand Marais, Grand Portage, and everywhere along the route to Tower.

113. *Quercus macrocarpa*, Michx.
On portage between Lake Seiganagah and Oshkosh Lake.

114. *Populus tremuloides*, Michx.
Common.

115. *Populus grandidentata*, Michx.
Common.

116. *Populus balsamifera*, L.
Mountain Lake and Moose Lake.

117. *Pinus Strobus*, L.
This species, with *P. resinosa*, common throughout the region.

118. *Pinus Banksiana*, Lambert.
Brule River, Red Rock, and along the boundary between Minnesota and Ontario west to Basswood Lake.

119. *Pinus resinosa*, Ait.

120. *Picea nigra*, Link.
Common in the swamps.
121. *Abies balsamea*, Miller.
Observed at all points along the route.
122. *Larex Americana*, Michx.
North Lake.
123. *Thuya occidentalis*, L.
A common tree in swamps.
124. *Juniperus Virginiana*, L.
Observed at several points along Lake Superior.
125. *Taxus Canadensis*, Willd.
Fond du Lac.
126. *Calypso borealis*, Salisb.
Grand Marais.
127. *Corallorhiza innata*, R. Brown.
Fond du Lac.
128. *Listera cordata*, R. Brown.
Rosebud Creek, Brule River, and Rove Lake.
129. *Listera convallarioides*, Nutt.
Brule River.
130. *Spiranthes Romanzoffiana*, Cham.
Portage between Long Lake and Burntside Lake, and on a the large island at east end of Lake Seiganagah.
131. *Spiranthes gracilis*, Bigelow.
Portage between Long Lake and Fall Lake.
132. *Goodyera repens*, R. Br.
Collected at many points along the route. Common
133. *Habenaria hyperborea*, R. Br.
Portage between Rat Lake and South Lake.
134. *Habenaria obtusata*, Richardson.
Common everywhere.
135. *Habenaria Hookeri*, Torr.
Granite River and at the east end of Knife Lake.
136. *Habenaria orbiculata*, Torr.
Rove Lake.
137. *Habenaria psycodes*, Gray.
Granite River and Otter Track Lake.
138. *Cypripedium acaule*, Ait.
Granite River.

139. *Iris versicolor*, L.
Grand Marais.

140. *Sisyrinchium angustifolium*, Mill.
Grand Marais.

141. *Smilacina trifolia*, Desf.
Near Brule River.

142. *Maianthemum Canadense*, Desf.
Fond du Lac and Grand Marais.

143. *Streptopus amplexifolius*, DC.
Grand Marais.

144. *Streptopus roseus*, Michx.
Grand Marais.

145. *Clintonia borealis*, Raf.
Fond du Lac and Grand Marais.

146. *Lilium Philadelphicum*, L.
Observed at two or three points along Lake Superior between Grand Marais and Grand Portage.

147. *Tofieldia palustris*, Hudson.
Grand Marais.

148. *Luzula spadicea*, DC., var. *melanocarpa*, Meyer.
Devil's Track River.

149. *Sparganium minimum*, Fries.
South Fowl Lake and Sucker Lake.

150. *Sagittaria variabilis*, Engelm.
Fall River and Fall Lake.

151. *Sagittaria heterophylla*, Pursh.
With *S. variabilis*.

152. *Potamogeton natans*, L.
Common in all inland waters.

153. *Potamogeton Pennsylvanicus*, Cham.
Rove Lake.

154. *Potamogeton amplifolius*, Tuckerm.
Rove Lake.

155. *Potamogeton heterophyllus*, Schreb.
Rove Lake.

156. *Potamogeton pauciflorus*, Pursh.
Rove Lake.

157. *Eriocaulon septangulare*, Withering.
Lake Seiganagah and small pond east of Sucker Lake.

158. *Scirpus fluviatilis*, Gray.
Island at the east end of Lake Seiganagah.

159. *Carex pauciflora*, Lightf.
Rove Lake.

160. *Carex intumescens*, Rudge.
South Fowl Lake.

161. *Carex lupulina*, Muhl., var. *pedunculata*, Dewey.
Pigeon River.

162. *Carex utriculata*, Boott.
Mosquito Bay, Gunflint Lake.

163. *Carex monile*, Tuckerm.
South Fowl Lake.

164. *Carex Tuckermani*, Dewey.
Ely and Barron.

165. *Carex retrorsa*, Schwein.
Mosquito Bay, Gunflint Lake.

166. *Carex Pseudo-Cyperus*, L.
Portage at east end of Otter Track Lake.

167. *Carex Houghtonii*, Torr.
Grand Marais and Mosquito Bay, Gunflint Lake.

168. *Carex filiformis*, L.
Grand Marais and Mountain Lake.

169. *Carex riparia*, W. Curtis.
Grand Marais.

170. *Carex alpina*, Swartz.
Grand Marais.

171. *Carex fusca*, All.
Grand Marais.

172. *Carex stricta*, Lam.
Grand Marais.

173. *Carex crinita*, Lam.
Barron.

174. *Carex Magellanica*, Lam.
Island at the east end of Lake Seiganagah.

175. *Carex limosa*, L.
Grand Marais and Daniels Lake.

176. *Carex arctata*, Boott.
Shore of Lake Superior near Brule River.

177. *Carex flava*, L.
Island at the east end of Lake Seiganagah.

178. *Carex flava*, L., var. *viridula*, Bailey.
Island at the east end of Lake Seiganagah.

179. *Carex livida*, Willd.
Grand Marais.

180. *Carex aurea*, Nutt.
Granite River near Pine Lake.

181. *Carex varia*, Muhl.
Grand Marais.

182. *Carex obesa*, All., var. *minor*, Boott.
South Fowl Lake.

183. *Carex polytrichoides*, Muhl.
Mawshequawcawmaw River.

184. *Carex tenella*, Schkuhr.
Rove Lake.

185. *Carex canescens*, L.
Rove Lake.

186. *Carex canescens*, L., var. *polystachya*, Boott.
Mosquito Bay, Gunflint Lake.

187. *Carex trisperma*, Dewey.
Rove Lake.

188. *Carex tribuloides*, Wahl., var. *Bebbii*, Bailey.
Grand Marais.

189. *Carex scoparia*, Schkuhr.
Mosquito Bay, Gunflint Lake.

190. *Carex adusta*, Boott.
Mosquito Bay, Gunflint Lake.

191. *Carex straminea*, Willd.
Grand Marais.

192. *Panicum depauperatum*, Muhl.
Mud Lake, Cook County.

193. *Panicum dichotomum*, L.
Knife Lake.

194. *Zizania aquatica*, L.
Fall Lake.

195. *Phalaris arundinacea*, L.
Gunflint Lake.

196. *Hierochloe borealis*, Roem. & Schultes.
Grand Portage.

197. *Oryzopsis Canadensis*, Torr.
Gunflint Lake.

198. *Muhlenbergia glomerata*, Trin.
Portage between Burntside Lake and Mud Lake.

199. *Brachyelytrum aristatum*, Beauv.
Rove Lake.

200. *Phleum pratense*, L.
At all old settlements. Introduced.

201. *Alopecurus geniculatus*, L.
At the east end of Basswood Lake.

202. *Agrostris scabra*, Willd.
Falls on Granite River one and a half miles below Gunflint Lake.

203. *Calamagrostis Canadensis*, Beauv.
South Fowl Lake.

204. *Calamagrostis stricta*, Trin.
Along the shore of Lake Superior four miles west of Grand Portage.

205. *Deschampsia cæspitosa*, Beauv.
Grand Portage.

206. *Deschampsia cæspitosa*, Beauv., var. Vasey.
Grand Marais.

207. *Trisetum subspicatum*, Beauv.
Grand Marais.

208. *Avena striata*, Michx.
Scott's Creek.

209. *Danthonia spicata*, Beauv.
Gunflint Lake.

210. *Poa nemoralis*, L.
Grand Portage.

211. *Poa nemoralis*, L., var. Vasey.
North shore of Lake Superior ten miles west of Grand Portage.

212. *Poa serotina*, Ehrhart.
South Lake Portage.

213. *Poa pratensis*, L.
South Lake Portage.

214. *Poa pratensis*, L., var. Vasey.
Grand Marais.

215. *Glyceria Canadensis*, Trin.
Portage between Burntside Lake and Mud Lake.

216. *Glyceria nervata*, Trin.
Ely, Fall Lake, Gunflint Lake and Grand Marais.

217. *Glyceria grandis*, Watson.
Ely.

218. *Glyceria fluitans*, R. Br., var. *minor*, Vasey.
Portage at western extremity of Gunflint Lake and North Lake Portage.

219. *Festuca tenella*, Willd.
South Fowl Lake.

220. *Festuca ovina*, L.
Grand Marais.

221. *Bromus ciliatus*, L.
Scott's Creek.

222. *Bromus Kalmii*, Gray.
Portage between Burntside Lake and Mud Lake.

223. *Agropyrum tenerum*, Vasey.(?)
Rove Lake.

224. *Elymus Canadensis*, L.
Grand Marais and portage at east end of Sucker Lake.

225. *Aspidium fragrans*, Swartz.
Parttidge Falls on Pigeon River, and at the falls at the northern outlet of Lake Seiganagah.

226. *Osmunda regalis*, L.
Partridge Portage.

227. *Botrychium Lunaria*, Swartz.
At the mouth of the Brule River, on the west bank.

228. *Lycopodium annotinum*, L.
This, with the three following, were observed throughout the region. None, however, were collected.

229. *Lycopodium obscurum*, L., var. *dendroideum*, Watson.

230. *Lycopodium clavatum*, L.

231. *Lycopodium complanatum*, L.

232. *Selaginella spinosa*, Beauv.
Grand Marais.

233. *Selaginella rupestris*, Spreng.
Grand Marais, South Fowl Lake, and Rove Lake.

234. *Sphagnum cymbifolium*, Ehrh.
Burntside Lake.

235. *Sphagnum fimbriatum*, Wils.
Burntside Lake.

236. *Sphagnum acutifolium*, Ehrh.
Grand Marais.

237. *Sphagnum Girgensohnii*, Russ.
Burntside Lake.

238. *Sphagnum Wulfianum*, Girgens,
Burntside Lake.

239. *Sphagnum intermedium*, Hoffm.
Burntside Lake.

240. *Cynodontium polycarpum*, Schimp.
Grand Marais.

241. *Cynodontium polycarpum*, Schimp., var. *strumiferum*, Schimp.
Grand Marais.

242. *Cynodontium virens*, Schimp., var. *Wahlenbergii*, Bruch. & Schimp.
Grand Marais.

243. *Dicranum montanum*, Hedw.
Ely.

244. *Dicranum flagellare*, Hedw.
Rat Lake and Barron.

245. *Dicranum fuscescens*, Turn.
Grand Marais.

246. *Dicranum scoparium*, Hedw.
Fond du Lac.

247. *Dicranum Drummondi*, Muell.
Grand Marais.

248. *Dicranum undulatum*, Turn.
Rove Lake.

249. *Fissidens incurvus*, Schwaegr.
Grand Marais.

250. *Fissidens adiantoides*, Hedw.
Grand Marais and Basswood Lake.

251. *Fissidens adiantoides*, Hedw., var. *immarginatus*, Lindb.
Gunflint Lake.

252. *Ceratodon purpureus*, Brid.
Collected at Grand Marais. Very common.

253. *Distichium capillaceum*, Bruch. & Schimp.
Grand Marais.

254. *Distichium inclinatum*, Bruch. & Schimp.
Grand Marais.

255. *Blindia acuta*, Bruch. & Schimp.
Grand Marais.

256. *Leptotrichum glaucescens*, Hampe.
Grand Marais.

257. *Grimmia apocarpa*, Hedw.
Grand Marais.

258. *Grimmia apocarpa*, Hedw., var. *rivularis*, Nees & Hornsch.
Grand Marais.

259. *Grimmia unicolor*, Grev.
Grand Marais.

260. *Racomitrium fasciculare*, Brid.
Grand Marais.

261. *Hedwigia ciliata*, Ehrh.
Grand Marais.

262. *Amphoridium Lapponicus*, Schimp.
Brule River.

263. *Ulota Hutchinsiæ*, Schimp.
Grand Marais.

264. *Orthotrichum speciosum*, Nees.
Grand Marais.

265. *Encalypta ciliata*, Hedw.
Grand Marais.

266. *Tetraphis pellucida*, Hedw.
Grand Marais.

267. *Tetraplodon mnioides*, Bruch. & Schimp.
Lake shore five miles west of Grand Marais. Near the Mawshequawcawmaw River.

268. *Funaria hygrometrica*, Sibth.
Common. Collected near Grand Marais.

269. *Bartramia pomiformis*, Hedw.
Grand Marais, Partridge Falls on Pigeon River, and falls at the northern outlet of Lake Seiganagah.

270. *Philonotis fontana*, Brid.
Grand Marais.

271. *Leptobryum pyriforme*, Schimp.
Burntside Lake.

272. *Webera polymorpha*, Schimp.
Lake shore three miles east of Grand Marais.

273. *Webera nutans*, Hedw.
Ely.

274. *Bryum bimum*, Schreb.
Grand Marais.

275. *Bryum roseum*, Schreb.
Fond du Lac, Grand Marais, and Barron.

276. *Mnium cuspidatum*, Hedw.
Grand Marais.

277. *Mnium affine*, Bland.
Fond du Lac.

278. *Mnium orthorhynchum*, Bruch. & Schimp.
Knife Lake.

279. *Mnium subglobosum*, Bruch. & Schimp.
Fond du Lac.

280. *Aulacomnium palustre*, Schwaegr.
Granite River.

281. *Atrichum angustatum*, Bruch. & Schimp.
Barron.

282. *Pogonatum alpinum*, Roehl.
Lake shore one mile west of Grand Marais.

283. *Pogonatum alpinum*, Roehl., var. *arcticum*, Brid.
Granite River.

284. *Polytrichum gracile*, Menz.
Burntside Lake.

285. *Polytrichum juniperinum*, Willd.
Grand Marais.

286. *Fontinalis antipyretica*, Linn., var. *gigantea*, Sulliv.
Mud Lake, Cook County.

287. *Neckera pennata*, Hedw.
Fond du Lac and Weyerhauser.

288. *Neckera oligocarpa*, Bruch. & Schimp.
Grand Marais.

289. *Leucodon sciuroides*, Schwaegr.
Falls at the northern outlet of Lake Seiganagah.

290. *Myurella julacea*, Bruch. & Schimp.
Rove Lake.

291. *Leskea obscura*, Hedw.
Falls at the northern outlet of Lake Seiganagah.

292. *Anomodon rostratus*, Schimp.
Falls at the northern outlet of Lake Seiganagah.

293. *Anomodon obtusifolius*, Bruch. & Schimp.
Fond du Lac.

294. *Pylaisia polyantha*, Bruch. & Schimp.
Rove Lake and Grand Marais.

295. *Pylaisia intricata*, Bruch. & Schimp.
Rove Lake.

296. *Pylaisia velutina*, Bruch. & Schimp.
Ely.

297. *Climacium dendroides*, Web. & Mohr.
Brule River near where it empties into Lake Superior.

298. *Hypnum gracile*, Bruch. & Schimp.
Barron.

299. *Hypnum recognitum*, Hedw.
Fond du Lac.

300. *Hypnum delicatulum*, Linn.
Barron.

301. *Hypnum lœtum*, Brid.
Burntside Lake and Barron.

302. *Hypnum salebrosum*, Hoffm.
Falls at the northern outlet of Lake Seiganagah.

303. *Hypnum plumosum*, Swartz.
Grand Marais.

304. *Hypnum strigosum*, Hoffm.
Grand Marais.

305. *Hypnum recurvans*, Schwaegr.
Gunflint Lake.

306. *Hypnum serrulatum*, Hedw.
Burntside Lake.

307. *Hypnum turfaceum*, Lindb.
Ely.

308. *Hypnum denticulatum*, Linn.
Granite River.

309. *Hypnum sylvaticum*, Huds., var. *orthocladium*, L. & J.
Granite River.

310. *Hypnum serpens*, Linn.
Ely.

311. *Hypnum orthocladon*, Beauv.
Falls at the northern outlet of Lake Seiganagah.

312. *Hypnum irriguum*, Hook. & Wils.
Falls at the northern outlet of Lake Seiganagah.

313. *Hypnum hispidulum*, Brid.
Barron.

314. *Hypnum chrysophyllum*, Brid.
Barron.

315. *Hypnum stellatum*, Schreb.
Burntside Lake.

316. *Hypnum aduncum*, Hedw., var.
Mawshequawcawmaw River.

317. *Hypnum uncinatum*, Hedw.
Ely.

318. *Hypnum uncinatum*, Hedw., var. *plumulosum*, Bruch. & Schimp.
Burntside Lake.

319. *Hypnum crista-castrensis*, Linn.
Fond du Lac, Grand Marais and Brule River.

320. *Hypnum reptile*, Michx.
Burntside Lake.

321. *Hypnum imponens*, Hedw.
Gunflint Lake.

322. *Hypnum arcuatum*, Lindb.
Barron.

323. *Hypnum pratense*, Koch, Ms.
Burntside Lake.

324. *Hypnum Haldanianum*, Grev.
Barron and Fond du Lac.

325. *Hypnum palustre*, Huds.
Grand Marais.

326. *Hypnum palustre*, Huds., var. *hamulosum*, L. & J.
Grand Marais.

327. *Hypnum cordifolium*, Hedw.
Barron and Burntside Lake.

328. *Hypnum Schreberi*, Willd.
Grand Marais.

329. *Hypnum splendens*, Hedw.
Fond du Lac.

330. *Hypnum triquetrum*, Linn.
Barron and Fond du Lac.

331. *Frullania Eboracensis*, Lehm.
Fond du Lac.

332. *Radula complanata*, Dumort.
Fond du Lac.

333. *Porella platyphylla*, Lindb.
Fond du Lac.

334. *Ptilidium ciliare*, Nees.
Grand Marais and Mawshequawcawmaw River.

335. *Blepharostoma trichophyllum*, Dumort.
Grand Marais.

336. *Cephalozia multiflora*, Spruce.
Grand Marais.

337. *Diplophyllum Dicksoni*, Dumort.
Grand Marais.

338. *Plagiochila asplenoides*, Dumort.
Grand Marais.

339. *Jungermannia barbata*, Schreb.
Lake Seiganagah.

340. *Scapania exsecta*, Aust.
Grand Marais.

341. *Pellia epiphylla*, Raddi.
Brule River.

342. *Pellia endiviæfolia*, Dumort.
Barron.

343. *Preissia hemisphærica*, Cogn.
Grand Marais.

344. *Riccia fluitans*, L.
Barron.

345. *Riccia natans*, L.
Ely.

MADISON, WIS., Feb. 22, 1893.

CONTENTS.

In the second part of volume IX, which will be issued about Christmas, will be included the proceedings of the Ripon field meeting and the 23d annual meeting. In an appendix will be printed a catalog of the library. Volume title page and index will also be included.