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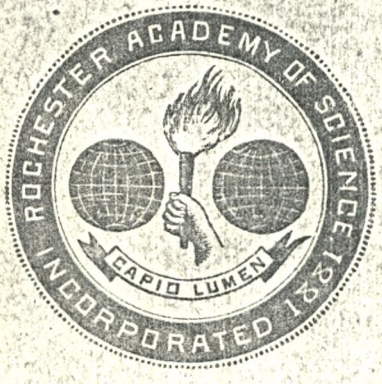
PROCEEDINGS

OF THE

ROCHESTER ACADEMY OF SCIENCE

VOLUME 3.



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ical magnitudes, into two classes :—*Pseudographs* or those symbols which have so far as we consider them no physical property in common with the magnitudes they represent, for example, the figures 1, 2, 3, and the letters of the alphabet. A large 2 is no different mathematically from a small 2, nor an italic *2* from a Roman 2. *Ideographs*, those symbols whose physical properties so far as we consider them may be considered as identical or coextensive with the mathematical properties of the magnitudes they represent.

In algebra magnitudes have two properties, size and sense of opposition. Thus, $+a$ and $-a$ have the same sizes but different senses, corresponding to the sense of debit and credit, or up and down, or right and left, that is, they have the sense of opposition.

The ideographs for these would be ———>, <——— which evidently represent two magnitudes of the same size but of opposite senses, that is, of mutual opposition.

Adopting the convention that normal or + magnitudes shall be represented by strokes headed to the right, negative or opposed magnitudes must, of course, be represented by strokes headed to the left.

So far ideographs have no very great advantage over the familiar pseudographs. The question naturally arises, how about the representation of $\sqrt{(-1)}$ by ideographs?

Before we can answer this we must ascertain clearly what is the meaning of the symbol $\sqrt{}$. A moment's reflection will show that it is the symbol of an operation to be performed upon its operand which amounts to finding a mean proportion between the operand and unity, such a result that its successive application twice to unity shall give the original operand. Thus, $\sqrt{}$ applied to a means the finding of such a quantity (multiplier) that applied twice successively to unity it shall give a as a result. Such a quantity is $\sqrt{a}$, for $\sqrt{a}(\sqrt{a} \times 1) = a$; $\sqrt{}(16) = 4$, for $4\ (4.1) = 16$. The test of our result is that a double application of its properties to unity shall produce the original operand.

Before going farther, too, we must ascertain clearly that *multiplication is the doing to the multiplicand what was done to unity to produce the multiplier.*

We are now prepared to ascertain what $\sqrt{(-1)}$ means when applied to ideographs. To make it more clear, let us phrase the symbol $\sqrt{(-1)}$, viz., find such a symbol that the performance upon it of the operation which produced it from unity, shall give the result -1.

In ideographs $+1$ and -1 would be represented by two strokes on the paper mutually opposed, thus, <——— ———>. Here the

plain question is, what can we do to ——> so that a repetition of the operation shall produce <——? The answer stares you in the face, viz., turn ——> to the position ↑, *i. e.*, swing it 90° counter-clockwise. A repetition of the operation swings it to the position <——. Hence, if +1 is represented by ——>, and —1 by <——, then $\sqrt{(-1)}$ is represented by ↑ and the ideograph of $\sqrt{(-1)}$ is a real symbol of the same class as the other symbols and no longer imaginary.

We might have swung ——> clockwise and have found a second symbol ↓ for $\sqrt{(-1)}$. This is in accordance with the algebraic proposition that extraction of square root gives two answers $\sqrt{(-1)} = \pm \sqrt{-1}$. ↑ is adopted as the equivalent of the positive answer and is denoted pseudographically by $+i = +\sqrt{(-1)}$ and ↓ by $-i = -\sqrt{(-1)}$.

Ideographs as here used are merely *strokes* upon the surface of the paper, the performance of the stroke carrying the pen *along the paper* through a certain distance in a given direction.

The addition of two strokes can always be considered as the equivalent of some third single stroke, thus: —> + ——> = ——> or ——> + ↑ = ↗.

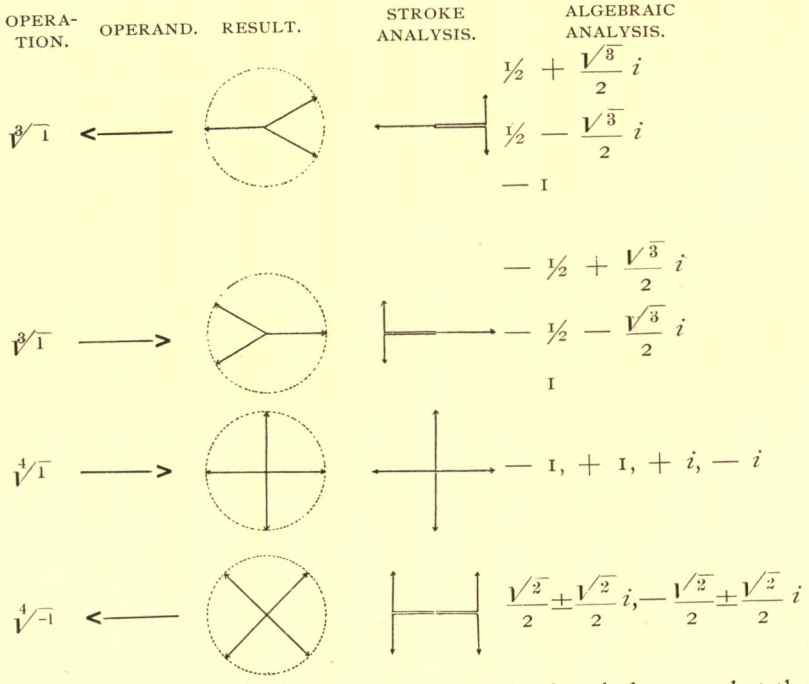
Arranging the pseudographs and ideographs in columns to facilitate comparison we have:

PSEUDOGRAPHS.	IDEOGRAPHS.
+ 1	—>
— 1	<—
$\sqrt{(-1)} = i$	↑
$-\sqrt{(-1)} = -i$	↓
$1 + i$	↑= ↗
$1 - i$	↓= ↘
$2 + i$	↑= ↗

Examination of the symbol $\sqrt{}$ evolves the *rule for the extraction of square root in strokes:—Halve the angle of the stroke and lay off along the bisector the mean proportional between the length of the stroke and unity for the length of the required stroke.*

In the case of roots of unity, this rule for square, cube, etc., roots becomes, *halve, third, quarter, etc., the angle of the stroke and lay off along the trisector, etc., a unit length.*

I give a few simple examples to illustrate the applicability of strokes :



The third column is arrived at by bearing in mind, *e. g.*, that the angle of ———> is either 0°, ±360°, ±720°, etc. A third of these gives 0°, ±120, etc.; a fourth, 0°, ±90°, ±180°, etc.

The last column is arrived at by simple trigonometric or geometric calculation.

Multiplication and division of strokes is performed with similar facility, but I shall not go into these details here. The formal discussion of the subject can be found in any book on the Theory of Functions.

To recapitulate, when the number concept was applied to concrete objects only, a negative number was unintelligible and imaginary, but when the number concept was applied to a more extended object, one where the sense of mutual opposition held, as in the case of debit and credit, the negative lost its unintelligibility and became real. But here the $\sqrt{(-1)}$ was still unintelligible and imaginary, to become in its turn real as soon as the number concept was applied to strokes, where the stroke representing $\sqrt{(-1)}$ is a real stroke though an imaginary number, just as -1 may be a real debt, but a purely imaginary number of inhabitants.

On this system of strokes hangs all the enormous modern development of the Theory of Functions, a development which has increased the volume of mathematical literature more in the last half than in the previous forty centuries, with a corresponding increase of power and extension of grasp.

The paper was discussed by several members.

DECEMBER 10, 1894.

The President in the chair. Forty persons present.

The Council report was adopted, which recommended : (1) The payment of certain bills ; (2) The appropriation of a sum not to exceed $50.00 to defray the expenses of the Popular Lecture Course for 1895.

PROFESSOR CHARLES WRIGHT DODGE read a paper

ON PROTOPLASM.

Illustrated by Microscopical Preparations.

JANUARY 14, 1895.

SIXTEENTH ANNUAL MEETING.

Vice-President J. M. DAVISON, in the chair. Forty-five persons present.

The Council recommended the appropriation of $10.00 to pay for lantern illustrations of the paper on the Geology of the Pinnacle Hills. The recommendation was adopted.

The annual reports of the officers were presented, as follows :

Secretary's Report.

The report of the Secretary, Professor Arthur Latham Baker, is summarized as follows :

Thirteen meetings have been held during the year, at which have been presented four papers in Botany ; two in Biology ; two in Engineering ; two in Mathematics ; two in Sanitation, and one each in Geology, Geography, Meteorology, Physics, Zoölogy. The informal communications have been six in Botany, four in Engineering, and one each in Astronomy, Biology, Meteorology, Physiology, Zoölogy.

Two memoirs of deceased members have been read.

A license has been granted Mr. E. H. Eaton to collect ornithological specimens.

Corresponding Secretary's Report.

The Corresponding Secretary, Professor Charles Wright Dodge, was unable to present his report at this meeting.

Treasurer's Report.

The report of the Treasurer, Mr. F. W. Warner, was presented at a later meeting, but is here summarized, as follows :

Cash received from former Treasurer, Mr. J. Eugene Whitney	$167 13	
From membership dues	240 00	
		$407 13
Paid Rochester Printing Co., printing of Proceedings	$230 16	
Paid F. A. Steward, map drawing	53 20	
Paid Miss F. Beckwith, writing	50 00	
Paid miscellaneous expenses	68 04	
		$401 40
Balance on hand		$5 73

Librarian's Report.

Miss Florence Beckwith, Librarian, read the following report :

Since the last annual report there have been added to the library 800 publications; 19 bound volumes and 781 pamphlets. These are received in exchange for our Proceedings, which are sent to all the leading scientific societies and magazines of the world.

Of the 800 publications received, 313 are from societies and institutions of the United States and 487 from foreign countries. The foreign contributions are as follows :

Canada	48	Austria and Hungary	21
Mexico	23	Norway	6
South America	9	Portugal	19
Central America	5	Sweden	28
Great Britain	27	Belgium	19
Germany	109	Switzerland	13
France	60	Australia	5
Italy	69	Trinidad	5
Russia	20	Japan	1

Botanical Curator's Report.

The report of the Curator in Botany, Mr. J. B. Fuller, was not read at the meeting, but is here presented, as follows :

During the year 1894, there have been added to the herbarium 437 specimens. The total number of mounted and labeled specimens is now 3,647, representing 1,976 species and varieties, and 511 genera.

Report of Botanical Section.

Read by Mrs. J. H. McGuire, Recorder of the Section.

During the past year the Botanical Section has held twenty-eight meetings, including the Botanical meeting of the Academy of Science held June 25, 1894, with an average attendance of ten persons ; the smallest number present at any meeting being four, the largest fifteen.

The meetings are held fortnightly, at the residence of Mr. William Streeter, No. 14 Scio street, to whose courtesy and generosity we are not only indebted for the free use of a place of meeting, but also of his extensive scientific library, microscopes, and other appliances necessary to the study of Botany.

The officers of the Section are: Chairman, MISS MARY E. MACAULEY; Vice-Chairman, MISS FLORENCE BECKWITH; Recorder, MRS. J. H. MCGUIRE.

Extracts from the Minutes of the Section.

January 12, 1894. Mr. Fuller exhibited pressed specimens of *Ranunculus fascicularis* Muhl., *R. septentrionalis* Poir, and *R. repens* L., explaining the points of difference between these three species.

An original paper on *Volvox globator* L.,* by Mr. A. M. Dumond, was read. Mr. Streeter illustrated the points made by Mr. Dumond, showing the forms of reproduction, sexual and asexual, with the microscope.

January 26, 1894. Mr. Baxter showed *Hepatica* in bloom. The plant was brought from the woods three weeks before and developed indoors.

Mr. C. C. Laney read an original paper on "Our Native Wild Flowers" and advised their cultivation in gardens. The various stations of the plants mentioned formed the chief topic of the discussion which followed.

Mrs. E. L. Maguire exhibited a collection of pressed plants from Indian Territory and Texas, from which specimens were selected for the herbarium.

February 23, 1894. Mr. Baxter showed a collection of violets, selected from his herbarium, showing the striking variations of plants of the same species, due to a different habitat and environment. These specimens were collected in Holland, Russia, New Siberia Islands, Finland, Peru; also in Ohio, Reading, Pa., New Dorp, Bergen, Adams Basin, and Penfield, N. Y. Specimens of the same species taken from our herbarium were shown and compared.

Miss Westfall, of California, was present and exhibited a portion of her large collection of marine algæ from the Pacific coast.

Mrs. George C. King showed pressed plants from Los Angeles and Lookout Mountain, Cal.

March 9, 1894. Dr. Anna H. Searing exhibited a collection of pressed violets from California, Colorado, the State of Washington, and some of the Southern States.

Mr. Dunbar exhibited a fine *Cypripedium candidum* Muhl., in flower, which was taken from the woods in the fall and wintered indoors.

*See Proceedings, Broch. 4, Vol. II., pp. 293-297.

In microscopical studies, some Pacific algæ were shown by Mr. Streeter.

March 23, 1894. Mrs. King showed specimens of the California pepper plant.

The Pacific algæ studies were continued under direction of Mr. Streeter. He also exhibited a specimen of a Hydroid.

Mr. Walton reported Hepatica in blossom March 16.

April 6, 1894. Dr. Anna H. Searing showed specimens from Virginia Beach, Va., collected by her on a recent visit to that place.

Mr. Streeter presented a fine microscopical exhibit. Among the objects shown were *Fragilaria virescens* Ralfs, *Grammatophora serpentina* Ralfs, *Licmorpha Californica* Grun., *Arachnoidiscus*, *Isthmia nervosa* Kütz, *Tabularia*, *Hyalodiscus*, and statoblast of *Crystatella*.

April 20, 1894. Mr. Dunbar stated that *Erythronium* does not flower until the bulbs are three years old and have reached a depth of eight inches underground. Mr. Walton remarked that his observations agreed with those of Mr. Dunbar.

In microscopical studies *Zygnema*, *Vaucheria*, *Tetraspora*, and *Meridion circulare* (Grev) Ag. were shown.

May 4, 1894. Mr. Walton showed *Mertensia Virginica* DC., having pink blossoms, *Phlox divaricata* L., *Erythronium albidum* Nutt., and several other plants.

May 18, 1894. Mr. Fuller exhibited an example of prolification in a tulip ; a perfect single flower borne upon a peduncle, one inch in length, rising from the center of a "double" flower.

Mr. Walton exhibited *Rumex venosus* Pursh., and *Lathyrus ornatus* Nutt., from Colorado.

Mr. Laney showed *Cratægus coccinea* L., having red stripes on the white petals and red stamens. This variation was thought to be caused by an insect.

Mrs. J. H. McGuire showed *Cerastium arvense* L., from Greece, N. Y. Mr. Baxter exhibited *Cardamine pratensis* L., from Penfield.

June 1, 1894. Miss Macauley exhibited *Geranium molle* L. This was the first time it had been reported in Rochester.

Miss Beckwith presented a typical specimen of *Amelanchier Canadensis* Torr. and Gray.

June 15, 1894. Mr. Fuller presented a hybrid willow—a cross between *Salix alba-vitellina* Koch, and *S. lucida* Muhl.

June 23, 1894. The annual excursion of the Section to Bergen swamp was made. Much of the swamp was found to be under water. The flowers, usually so abundant, were scarce, with the exception of *Sarracenia purpurea* L.

July 9, 1894. Mr. Baxter exhibited *Solanum Carolinense* L., and *Arenaria lateriflora* L., both rare.

July 23, 1894. Mr. Baxter showed *Epipactis viridiflora* Reichb., from the bank of the Genesee river. The last edition of Gray's Manual gives Buffalo and Syracuse as the only known stations.

A bouquet of pressed flowers from Crècy-en-Brie, France, sent by Mrs. A. M. Dumond, was received.

August 6, 1894. Mr. Dunbar exhibited *Vincetoxicum nigrum* Moench. Miss Beckwith showed *Specularia perfoliata* A. DC., *Veronica Virginica* L., *Habenaria hyperborea* R. Br., *Hydrastis Canadensis* L., in fruit, *Morus rubra* L., *Pyrus arbutifolia* L. f., *Nymphæa odorata* var. *minor* Sims, and leaves of *Carpinus Caroliniana* Walter, having peculiar variations probably due to arrested development.

August 20, 1894. Mr. Baxter showed *Woodwardia Virginica* Smith, and reported a new station for it at Adams Basin ; also *Polanisia graveolens* Raf.

September 3, 1894. Professor W. H. Lennon, of Brockport, exhibited leaves of *Sassafras* showing variations of form.

Miss Beckwith showed *Mollugo verticillata* L., and *Datura Tatula* L., from Brooklyn Navy Yard.

Mr. Baxter exhibited *Goodyera repens* R. Br., *Drosera intermedia* var. *Americana* DC., *D. rotundifolia* L., *Utricularia intermedia* Hayne, *U. cornuta* Michx., and *U. resupinata* B. D. Greene, from Mendon ponds.

Mr. A. M. Dumond presented the Section with a collection of pressed specimens from France.

Dr. Searing showed a number of plants collected by her on Long Island.

In microscopical studies Mr. Dumond exhibited *Rivularia* attached to *Ceratophyllum*. Mr. Streeter showed *Scenedesmus*.

September 17, 1894. Among the large number of plants exhibited were *Spartina cynosuroides* Willd, by Mr. Baxter, and *Celtis occidentalis* L., by Mr. Dunbar, found by Mr. Laney.

October 19, 1894. Dr. Searing showed a number of grasses from Long Island.

Mrs. King showed *Pycnanthemum linifolium* Pursh., from Canandaigua Lake.

Mrs. E. L. Maguire showed *Monarda citriodora* Cerv., from Texas.

Mr. Streeter exhibited specimens of *Oscillaria* under the microscope.

November 30, 1894. Mr. Baxter showed *Arceuthobium pusillum* Peck, from Mendon.

The following resolutions were presented by Mr. J. Y. McClintock and were adopted :

WHEREAS : It is necessary to have an accurate Topographical Map of the State of New York in order to develop its wonderful natural resources and to study the possibilities of improving its hundreds of water powers, to drain swamps, protect valuable lands from injury by floods, protect the water supplies of cities, improve roads, preserve and create forests, provide water supply to canals, study the geology and natural history, locate mines and quarries, investigate the agricultural possibilities, etc., and

WHEREAS : Such a survey and maps have been partially completed at the joint expense of the State of New York and the United States Government, at the least possible cost to the State,

Resolved : That the Rochester Academy of Science earnestly requests the Legislature to make the necessary appropriations to complete the survey of the State in the shortest time; and

Resolved : That this Academy urges that the original sheets of the survey of that part of the Genesee Valley not yet completed be made upon a scale of not less than one in twenty thousand, because while the cost will not be greatly increased the value of the survey will be far greater and will be more valuable for the purposes required, and

Resolved : That copies of these resolutions be forwarded to the Senator and Assemblyman from this district and to the State Engineer and Surveyor.

ELECTION OF OFFICERS.

The annual election of officers for the ensuing year was held and resulted as follows :

For President, HERMAN L. FAIRCHILD.
For First Vice-President, J. M. DAVISON.
For Second Vice-President, J. EUGENE WHITNEY.
For Secretary, ARTHUR LATHAM BAKER.
For Corresponding Secretary, CHARLES WRIGHT DODGE.
For Treasurer, F. W. WARNER.
For Librarian, MISS FLORENCE BECKWITH.
For Councillors, C. C. LANEY, *till 1898*,
DR. G. W. GOLER, *till 1898*.

The President had been announced to present a paper upon The Geology of the Pinnacle Hills, but was absent on account of illness.

The Secretary presented an informal paper upon the subject of

DIRECTED MAGNITUDES.

FUNDAMENTAL OPERATIONS IN MATHEMATICS.

BY PROFESSOR ARTHUR LATHAM BAKER.

Empty space may be considered as a continuum of *positions*. A number of neighboring positions taken together we will consider as locating a point in space and will designate as a *point*, and the number of positions composing it, its *weight*.

The characteristics of points are *weight* and *location*.

I.

Considering for the present only the weights, *what operations can be performed?* Obviously we can combine the weights, either in their normal condition (addition), or we can reverse the operation (subtraction), or we can consider the weight of one point as the symbol of an operation to be performed on the weight of the other. The weight has only one characteristic : the manner in which it differs from unity. As a symbol of operation, this manner of difference is either its evolution from unity, or its conversion into unity.

If we take the first manner of difference as the process which is to be repeated, we call it multiplication, or the doing to the operand whatever was done to unity to produce the operator.

If we take the second manner of difference as the process which is to be repeated, we call it division, or the doing to the operand whatever was done to the operator to produce unity.

II.

Hitherto we have considered the various positions composing a point as merely bunched together, but if we consider these positions as arranged in a certain order or sense, then a point has in addition to its weight the characteristic of normalcy or opposition of the weight. The *normal sense* or direction of arrangement we designate by +, the *reverse sense* or direction by —.

In addition to the normal and reversed senses of the weight, we have also the *mean reversed* sense indicated by $\sqrt{-}$ (see Algebraic Symbols, Am. Jour. Math., xviii., 62).

The weights, having merely magnitude (with sense) are *scalars*, that is, magnitudes whose properties can be scaled off on a scale.

Out of the weights of the points, then, we get six fundamental operations: addition, subtraction, multiplication, division, reversion and mean reversion—*and no others.*

III.

Applying these six operations to scalars, the only magnitude so far, we get the following results:

The sum of two scalars is a scalar;

The difference of two scalars is a scalar;

The product of two scalars is a scalar;

The quotient of two scalars is a scalar;

The reversion of a scalar is a scalar;

The mean reversion of a scalar is a *vector* (loc. cit.), a quantity having magnitude and direction.

Applying the six algebraic operations to this new quantity, the vector, we get:

The sum of two vectors is a vector;

The difference of two vectors is a vector;

The product of two vectors is a *quaternion* (a scalar plus a vector, a scalar, or a vector, according to the position of the mean reversing operator or symbol) (loc. cit.);

The quotient of two vectors is a quaternion;

The reversion of a vector is a vector;

The mean reversion of a vector is a quaternion.

Applying the six operations to this new quantity, the quaternion, we get :

The sum of two quaternions is a quaternion ;
The difference of two quaternions is a quaternion ;
The product of two quaternions is a quaternion ;
The quotient of two quaternions is a quaternion ;
The reversion of quaternion is a quaternion ;
The mean reversion of a quaternion is a quaternion ;

} Including the limiting cases, the scalar and the vector.

Out of the weights of the points, then, we get *two fundamental* quantities : scalars, vectors (and their combination, quaternions) and *no others*. The introduction of such terms as versors, turning factors, quadrantal versors, etc., etc., is merely cumulative, and unnecessary except as a convenient mode of designating some particular phase of the two fundamental quantities, the scalar and the vector. As we have seen, a quaternion is either the product of two vectors, or the sum of a scalar and a vector, and as a *symbol of operation* designates the conversion of one vector into another. This avoids such artificial and mystifying definitions of a quaternion as, a quasi mechanical operator . . . . composed of a magnitude and a turning factor, etc.

A vector, considered as a symbol of operation, is a mean reverser. This is the inevitable result of our definition of multiplication (loc. cit.). When the vector occurs in combination with a scalar (the quaternion) it does not necessarily need a new name (turning factor, etc.). It simplifies not only the theory but also the use of quaternions to consider them as simply a combination of a scalar and a vector, to be operated with and upon by the rules applicable to scalars and vectors. This method of looking at scalars and vectors (quaternions) binds the whole subject of Reals, Imaginaries and Quaternions into a united and homogeneous whole, the quaternion being the inevitable logical expansion of the elementary algebraic conceptions. It avoids all assumptions as to "the definition of the multiplication of i into j", all arbitrary retention or rejection "of the old laws of multiplication", all introduction of arbitrary "laws", all attaching to multiplication of "any signification we please when we speak of vectors", etc.

IV.

The weights of the points have by their characteristic of difference from unity (their only characteristic) indicated the operation of multiplication, and its inverse, and nothing else.

Making use of the space concepts of symmetry and completeness and carrying out this operation of multiplication in utmost symmetry and completeness, we have as the only possible definite result, $(1 + \frac{1}{\infty})^{\infty} = 2.718.... = e$, one of the pair of numerical values so obtrusive in all nature.

If we bunch the positions which constitute the point and distribute the points into the most symmetrical shape, the number of positions or the weight will be $k\pi$, a multiple of the other numerical value so omnipresent in the universe, $\pi = 3.141592...$

As might be expected from this investigation, no other numerical operations being indicated, there are no other numerical values comparable with e and π.

V.

A *vector* is a quantity having size, sense and *direction of extension*, but not location of extension, such as impulse, velocity, distance toward α Centauri, etc.

A *geometrical quantity* or *posited vector* is a magnitude having size, sense, direction and location of extension, such as velocity along a given path, etc. *Size* of *extension* is the size in the ordinary acceptation of the term. *Direction* or *quality of extension* is that property of extension which prevents the quantities from coinciding when brought together. Parallel lines have the same quality of extension. Solids have no distinctive extension and are, therefore, scalars. Geometrical quantities have the same *location of extension* when the qualities are not only the same but coincident: the extension of the one is the continuation of the extension of the other.

Geometrical quantities are *equal* when their properties are the same, viz., magnitude of extension, direction of extension and location of extension.

VI.

We now consider the location of points, as well as their weights, first taking the case of unit points. In this case it is almost axiomatic that the sum of two unit points will be the point midway between them (called the *mean point*) with a weight of two, since this is the only result that combines the properties of the components, taking into consideration both weights and locations, and which gives each the same potency in determining the result.

An extension of this thought will show that in the case of points with unequal weights the mean point must be in line with the com-

ponents and at a distance inversely proportional to the weights of the components, with its weight the sum of the weights of the components. Accordingly if p_1, p_2, m_1, m_2 designate the points and weights

$$m_1 p_1 + m_2 p_2 = (m_1 + m_2)\,\bar{p},$$

where $\bar{p}$ designates the mean point.

This can be written $m_2 (p_2 - \bar{p}) = m_1 (\bar{p} - p_1)$.

The factors $(p_2 - \bar{p})$, $(\bar{p} - p_1)$ are inversely proportional to the weights of the components and, therefore, proportional to the distances of the mean point from the components, and, therefore, with the proper unit of measure, equal to these distances.

In $p_1 + mp_2 = (1 + m)\,\bar{p}$, as m decreases, the mean point $\bar{p}$ approaches p_1, coinciding with it for $m = 0$, and finally passes beyond it to ∞ as m approaches -1, and the equation becomes

$$p_1 - p_2 = 0\bar{p}$$

that is, the difference of two unit points is a point of zero weight at ∞. The meaning of a zero point at ∞ can be ascertained by considering its effect.

If $p\infty$ denote a point at ∞

$$mp_1 + p\infty$$

is a mean point of weight $(m + 1)$ lying in a determinate direction. As m increases, the mean point approaches p_1, coinciding with it at the limit $m = \infty$, or dividing by $m = \infty$, $p_1 + 0p\infty$ is a mean point coincident at the limit with p_1, but in a determinate direction of approach, or, in other words, $0p\infty$ has merely the effect of assigning direction, that is, it is a vector, and, therefore, $p_1 - p_2 = 0p\infty$ is a vector. The length of the vector $p_1 - p_2$ is found from the equation $m_2 (p_2 - \bar{p}) = m_1 (\bar{p} - p_1)$ to be equal to the distance between the points, measured naturally from the subtrahend to the minuend. We might have supposed *a priori* that the only difference between two unit points would be difference of location, a vector, that which is necessary to convert one point into the other.

If $p_1 - p_2 = p_3 - p_4 = \ldots = 0p\infty$, these vectors cannot be posited; their equality must be of magnitude and direction only—excepting the limiting case of collinearity.

VII.

Considered as a symbol of operation, what is the potency of p_2 on p_1?

The only difference between p_2 and p_1 is one of location, and the only way we can impress this difference of location on p_1 is to carry it

to the location of p_2. But this amounts to a transference, a vector. As this operation results in the formation of a new quantity, the vector between the two points, the operation is called *combinatory multiplication* to distinguish it from algebraic multiplication of weights. This gives us the definition :—*A combinatory or geometrical product of two quantities not having an element of their extension in common, is the geometrical quantity produced by the guided factor as it moves over a path determined by the guiding factor.*

The guided factor is written first. Thus, $p_1 p_2$ is the posited vector whose magnitude, direction and location of extension are determined by the movement of p_1 to p_2. Movement in the opposite direction would, of course, have a different sign, or $p_1 p_2 = -p_2 p_1$, giving us the *alternative law of multiplication.* Evidently $p_1 p_1 = 0$, or *the product of two identical factors is zero.*

Since the only properties of a vector are magnitude and direction, its guiding influence on a point must be to make it move a distance and direction determined by the vector, and $p_1 \varepsilon$ (ε denoting a vector) becomes a vector through a fixed point. Hence :—*Guiding a point by a vector converts the point into a posited or point vector, or locates the vector.*

Guiding a vector by the location of a point locates the vector through the point. Guiding the magnitude of extension of the vector by the zero magnitude of the point must be just the opposite of guiding the zero magnitude of the point by the magnitude of the vector and hence must reverse the vector. Or, *guiding a vector by a point locates the vector and reverses its direction.* Thus, $p_1 \varepsilon = -\varepsilon p_1$.

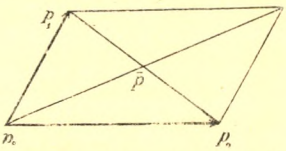
Similarly the *product of two vectors* is the plane area generated by the movement of the first vector as it is guided by the characteristics (magnitude and direction) of the second vector. As the angle between the two vectors passes through π the area passes through zero. Hence :—*The sense of the area is + or — according as the guided vector is guided by a vector on its left or right, or vice versa.* Thus, $\varepsilon_1 \varepsilon_2 = -\varepsilon_2 \varepsilon_1$.

Guiding a point by the characteristics of a point vector (posited vector), magnitude, direction and location of extension, must result in a posited plane area double that of the triangle determined by the point and the posited vector. Denoting the posited vector by $p_2 p_3$, we have for the resulting area $p_1 p_2 p_3$. Arranging the products of the three points in all possible ways, we find that the only way to separate

the equal areas into two sets is by the adoption of the *cyclical* and *associative laws*, viz.,

$$p_1p_2p_3 = p_3p_1p_2 = p_1 \cdot p_2p_3 = p_1p_2 \cdot p_3 = \ldots = -p_2p_1p_3 = \ldots\ldots$$

From the analogy of vectors to velocities it is evident that—*The sum of two coplanar posited vectors is a vector passing through the common point of their extensions and equal in length and direction to the resultant of the two vectors considered as velocities ;* that is



$$p_0p_1 + p_0p_2 = 2p_0\bar{p}$$
$$= 2p_0\frac{p_1+p_2}{2} = p_0(p_1+p_2)$$

Hence we have the *distributive law for the multiplication of three points.* By reversing the direction of one of the vectors we get :—*The difference of two co-initial posited vectors is a vector through the common point of their extensions and equal in length and direction to the vector connecting their ends.*

For parallel vectors, the same modifications of these rules hold as in the case of impulses, and the difference of two equal parallel posited vectors becomes

$$L_1 - L_2 = p_1\varepsilon - p_2\varepsilon = (p_1 - p_2)\varepsilon = 0p_\infty\varepsilon = \text{a zero vector at } \infty.$$

As in the case of the zero point at ∞, we find that the zero vector at ∞ becomes a mere plane direction, a plane vector.

VIII.

Guiding a posited vector by the characteristics of a posited vector, magnitude, direction and location of extension, gives a parallelopiped with the given vectors as edges.

In plane space, since the posited vectors must have an element of their extensions in common, viz., a point, we can write $L_1 = p_0p_1$, $L_2 = p_0p_2$. Of the products possible (all equal plane areas) by different arrangements and associations, the two p_0's not being allowed to come together in the same set, we find that the only possible basis of division into two sets is the rule :—*Looking from (or along) the guided factor, if the points of the guiding (or guided) factor run in cyclical order, or forward with the operand on the right, the product is unchanged, and vice versa.*

Thus, $p_0p_1 \cdot p_0p_2 = p_0 \cdot p_0p_1p_2 = -p_0 \cdot p_0p_2p_1 = -p_0p_2 \cdot p_0p_1$

or, $$L_1 L_2 = -L_2 L_1$$

that is :—*The product of two coplanar posited vectors is not commutative.*

This product introduces a new result. Out of the product of the two posited vectors, each having magnitude, direction and location of extension, we get, as shown above, a point p_0, the common element of the posited vectors, and a scalar area $p_0p_1p_2$, that is, the two factors have produced a quantity of a lower order than either of the factors. This is called a *regressive product.*

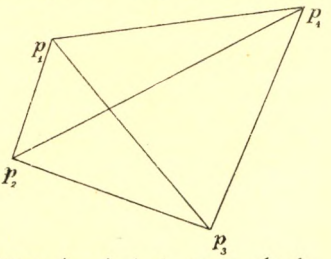
We might have expected this, for out of the combination of the two posited vectors, the common element of extension, the point in this case, is the only quantity that has any distinctive geometric characteristic, the area generated being a mere scalar, differing from all other areas in magnitude only, and the product of the two posited vectors is a weighted point.

The same considerations apply to the product of a posited vector and a posited area, etc., thus suggesting the rule :—*The product of two posited quantities which have a common element of extension is that element multiplied by some scalar.*

Guiding a vector by two others in succession gives the parallelopiped having the vectors for its edges. The product of four points is in a similar manner the parallelopiped six times the connecting tetrahedron. Arranging the products of the four points in the possible different ways, taking into account the association into single, double and triple factors, we find that the only basis of division into two classes is the rule :—*Looking from (or along) the operator if the points of the operator (or operand) run in cyclical order the result is unchanged.*

Hence,

$$\begin{aligned} p_1p_2p_3p_4 &= p_1p_2p_3 \cdot p_4 = Pp_4 \\ &= p_1p_2 \cdot p_3p_4 = L_1 L_3 \\ &= p_3p_4 \cdot p_1p_2 = L_3 L_1 \\ &= -p_4 \cdot p_1p_2p_3 = -p_4 \cdot P \end{aligned}$$



$p_4 \cdot p_1p_2p_3$ is negative because viewed from p_4, $p_1p_2p_3$ runs clockwise, whereas when p_4 is viewed from $p_1p_2p_3$, $p_1p_2p_3$ runs counter clockwise. Hence :—*The product of a point and a posited plane vector (P) is not commutative; the product of two diplanar posited vectors is commutative.*

In the planar product of a point and two posited vectors, we get, as might be expected, a *mixed product*, regressive from the product of the two posited vectors, and combinatory from the result of the point into the regressive point, viz.:

$$p\,L_1\,L_2 = p\cdot p_0p_1\cdot p_0p_2 = p\cdot p_0\cdot p_0p_1p_2 = pp_0\cdot p_0p_1p_2$$

= a posited vector with a weight $p_0p_1p_2$.

The product of three coplanar posited vectors :

$$\begin{aligned} L_1\,L_2\,L_3 = L_1\cdot L_2\,L_3 &= L_1\cdot p_1\cdot mp_1p_2p_3 \\ &= L_1p_1\cdot mp_1p_2p_3 \\ &= \beta p_1p_2p_3\cdot mp_1p_2p_3 = m\beta\,(p_1p_2p_3)^2 \end{aligned}$$

m, β, being scalars, and p_1, p_2, p_3 the points of intersection of the posited vectors.

IX.

Two points are independent of each other, that is, one cannot be expressed in terms of the other, whereas of three collinear points, any one can always by a proper adjustment of weights be considered as the mean point of the other two, that is, is pendable on them, to coin a word for the moment.

Of three points at random, no one can be made the mean of the other two, and, therefore, *three points are independent.* If a fourth point be introduced into the plane of the three, it can by a proper adjustment of weights be made a mean of the other three, and, therefore, *four or more co-planar points are pendable.* Similarly *four points in space are independent; five or more points in space are not independent.* Two non parallel vectors are independent ; two parallel vectors are not independent. Three vectors not parallel to a plane are independent, but not independent when parallel to a plane. Four or more vectors are not independent. We have found the product of two points to be the posited vector between them. If we attempt to multiply by a new point collinear with these, the combinatory product is nil. Similarly with three vectors in a plane, and so on. This suggests that the *product of pendable factors is nil*, which will be found to hold for four coplanar points, three coplanar vectors, etc., unless the product of previous factors (counting from the right as written) becomes regressive or scalar. For example, in the product of the three coplanar posited vectors $L_1\,L_2\,L_3$ of section VIII.

Hence the laws of section VII. should have been restricted to independent factors.

JANUARY 21, 1895.

SPECIAL MEETING.

Held in the hall of the Chamber of Commerce, the President in the chair. Seventy-five persons present.

The meeting was called for the purpose of presenting the following paper :

THE NEW CONDUIT OF THE ROCHESTER WATER WORKS.

BY MR. EMIL KUICHLING.

The paper was illustrated by a large number of lantern views.*

[Following the adjournment of the Society a conference was held of members and others interested in Engineering Science for the purpose of organizing a Section of Engineering.

The report of this and other meetings of the Section will be found in the Section Report made at the annual meeting, January 14th, 1896.]

JANUARY 28, 1895.

The President in the chair. Forty persons present.

The following communication was read :

ROCHESTER, Jan. 28, 1895.

PROFESSOR H. L. FAIRCHILD,
President Rochester Academy of Science.

DEAR SIR :—

I beg leave to report that on Monday, January 21st, the gentlemen whose names are given below met at the Chamber of Commerce and organized as the Engineering Section of the Rochester Academy of Science by electing MR. EMIL KUICHLING permanent Chairman and J. Y. MCCLINTOCK Recorder.

Very respectfully yours,

J. Y. MCCLINTOCK.

*The substance of the paper is printed in Mr. Kuichling's report as Chief Engineer of the Rochester Water Works, January 1, 1896, in the 19th and 20th Annual Reports of the Executive Board ; also in the "Engineering Record," April 13 to May 25, 1895, inclusive, and an abstract in "Engineering News" of April 11, 1895. The articles in the two journals contain numerous illustrations of plans and details of the work.

Upon motion of MR. MCCLINTOCK the Society formally ratified the organization of the Engineering Section.

On motion of MR. EMIL KUICHLING the rules relating to the election of members were unanimously suspended and the following named persons who would join the Engineering Section were nominated and formally elected active members of the Society :

W. M. ALBAUGH,
HOUSTON BARNARD,
JOHN BISGOOD,
F. A. BROTSCH,
LEGRAND BROWN,
ROBERT CARTWRIGHT,
GATES A. CLARK,
EDWIN A. FISHER,
FRED FORCE GORDON,
WILLIAM C. GRAY,
HORATIO JONES,
WILLIAM F. JORDAN,
ALFRED C. LEWERENZ,
WILLIAM S. MCMILLAN,
C. N. MUNGER,
CLARENCE R. NEHER,
H. T. POWELL,
JACOB M. C. QUARLE DE QUARLES,
CHARLES L. RAYMOND,
STUART ELY SILL,
JOHN F. SKINNER,
WILLIAM J. STEWART,
WILLIAM R. STOREY,
GAYLORD THOMPSON,
GEORGE S. TIBBITS,
FRANK H. CLEMENT,
FRANK W. BRISTOW,
JOHN A. DAVIS.

The following preamble and resolutions were presented by MR. J. Y. MCCLINTOCK :

" WHEREAS, A joint Legislative Committee appointed to consider which of the present State Commissions could be properly dispensed with has reported in favor of abolishing the State Weather Bureau, and

" WHEREAS, Such Bureau has been of great value to the State during the years of its existence, and

" WHEREAS, It having been of little expense to the State, most of the work being performed by voluntary observers, it is believed that the report of the Joint Committee must be based upon a misconception as to the work of this Bureau, and its value to the State, therefore,

" *Resolved*, That the Secretary of the Rochester Academy of Science be hereby directed to send a copy of this resolution to the Senator and Members of Assembly from this County, requesting

" them to use all honorable means to prevent the abolishing of this " Bureau on the ground that its work has not only been of great " value in the past, but by continuing its work the records which it " makes will acquire more value to science from year to year."

In the discussion upon these resolutions MR. GEORGE W. RAFTER spoke as follows :

This Bureau was created by, and organized under Chapter 148, Laws of 1889, and re-organized and placed under the department of Agriculture by Chapter 338, Laws of 1893. Up to 1893, $4,500 was appropriated annually for the maintenance of the Bureau, but it was not until 1893 that as much as this amount was spent in any one year. The annual report for that year shows an unexpended balance of $3919.66. There are now about ninety voluntary observers, who each month furnish the service with meteorological observations.

For three years MR. E. T. TURNER gave his entire time to the work of this Bureau without compensation. At present he receives $100 per month.

Aside from the cost of printing and the purely clerical work of preparing the monthly bulletins and the cost of instruments, the service has been conducted without expense to the State. The distribution of the monthly bulletins and reports is effected through the Post Office without cost to the State, under a franking privilege extended by the United States Government. A proposition to abolish the Department is therefore, in effect, a proposition to prevent a large number of earnest people from doing important scientific work gratuitously.

The resolutions were unanimously adopted.

The first lecture of the Popular Lecture Course for the season of 1895 was then given by Mr. J. D. MALLONEE, of Buffalo, entitled :

THE STRUCTURE OF ROCKS AS SHOWN BY POLARIZED LIGHT.

The lecture was illustrated by projections of rock sections upon the screen. A vote of thanks was tendered the lecturer.

FEBRUARY 11, 1895.

The President in the chair. Seventy-five persons present.

The following candidates were nominated and under suspension of the rules were elected active members or the Society:

FRANK L. DODGSON, J. L. LITTLE, FRED H. CRAFTS, GEORGE A. HOTCHKIN.

The Treasurer made a verbal report intended for the annual meeting. (See page 156.)

The Council report recommended the payment of certain bills, which were ordered paid.

In the absence of MR. J. STANLEY-BROWN, who had been announced to deliver the second Popular Lecture, the President, PROFESSOR H. L. FAIRCHILD, exhibited a series of lantern slides illustrating certain features in the local geology.

FEBRUARY 14, 1895.

SPECIAL MEETING.

The President in the chair. A large audience present.

The second lecture of the Popular Lecture Course, which had been deferred from February 11, was given by MR. JOSEPH STANLEY-BROWN, of Washington, entitled:

THE PRIBILOF ISLANDS AND THE SEAL INDUSTRY.

The lecture was illustrated by a large number of lantern views. The lecturer was tendered a vote of thanks.

FEBRUARY 25, 1895.

The President in the chair. Twenty-five persons present.

The following paper was presented:

THE DESPOTISM OF THE PLURALITY.

By Mr. J. Eugene Whitney.

The paper was illustrated by statistical charts and by practical illustration of the Swiss method of conducting elections. The paper was discussed by several members and visitors.

[Following adjournment the subject of organizing a Section of Social and Economic Science was discussed. Signatures were obtained to a request for such a Section, and the matter was left in the hands of a Special Committee, consisting of Mr. F. W. Warner, Temporary Chairman, Mr. W. R. Storey, Temporary Secretary, and Mr. J. Eugene Whitney.]

March 11, 1895.

The President in the chair. Thirty persons present.

The following named persons were proposed for membership and under suspension of the Rules were unanimously elected, by formal ballot: John W. Kenyon, J. Watson Sims, O. H. Strowger.

The following paper was then read:

THE TEETH OF MAN.

By Mr. Charles H. Ward.

The paper was illustrated by a series of dentological preparations and material in comparative dentology; and by a large number of human skulls illustrating normal and abnormal growth of the teeth.

March 25, 1895.

The President in the chair. A large audience present.

The third lecture in the Popular Lecture Course was given by Professor W. W. Rowlee, of Cornell University, entitled:

THE EVOLUTION OF SEEDS.

The lecture was illustrated by a series of lantern views. A vote of thanks was tendered the lecturer.

April 8, 1895.

The President in the chair. Twenty-five persons present.

The Council report recommended the payment of certain bills, and that Professor W. W. Rowlee, of Cornell University, be elected a Corresponding Member.

Professor Rowlee was elected and the bills ordered paid.

The following paper was then presented:

DIPHTHERIA AND ANTI-TOXINE.

By Professor Charles Wright Dodge.

The paper was illustrated by apparatus, cultures and microscopic preparations.

April 22, 1895.

The President in the chair. A large audience present.

The fourth lecture of the Popular Lecture Course, upon the Panama Canal, by Mr. Adelbert Cronise, which had been announced for this evening, was not given on account of the lecturer being in the Hawaiian Islands. As a substitute the President of the Academy presented the paper which he had been unable to read at the Annual Meeting, entitled:

THE GEOLOGY OF THE PINNACLE HILLS.

By Professor Herman Leroy Fairchild.

[abstract.] *

This range of hills, lying along the southern edge of the city of Rochester and extending from Brighton to the Genesee river, is of peculiar geologic interest, and the location and trend with complex

*The substance of this paper, with a map, is published in the American Geologist, Vol. XVI, pages 39-51, July, 1895.

structure and composition made the hills a puzzle to earlier students. In 1892 the hills were observed by Mr. Warren Upham, who published in 1893 in these Proceedings* a paper describing them as an Esker, or gravel ridge, laid down in the ice-walled channel of a glacial river. After detailed study of the deposits the present writer finds an explanation of their genesis radically different from that of Mr. Upham.

The Pinnacle hills were not accumulated in the bed of an overloaded stream, flowing toward the ice front, but were piled along the edge of the glacier. They are part of a frontal moraine and consist of the debris washed out of the ice sheet by the drainage, along with considerable unmodified drift deposited directly by the ice. The hills are essentially morainal, but being chiefly waterlaid drift, sand and gravel, are technically called Kame and may properly be termed Kame-moraine. The various reasons for this interpretation of their origin are briefly epitomized as follows :

The hills are not a ridge but a belt of knolls; the range having a curvilinear trend, with the convexity southward. The general direction of the chord of the arc is W. 15° S. The morainal deposit is continued westward from the Genesee river as a low but distinct moraine as far as Albion, which was first traced by Mr. Frank Leverett. Other morainal phenomena occur eastward and beyond the Irondequoit gulf. The topography of the range is emphatically morainal, knob and basin, or mound and kettle. The striæ upon the underlying rock, Niagara limestone, are in two sets, the older having a direction S. 40°–60° W. and the later nearly at right angles to the curving moraine. The northward face of the range is very steep and irregular, the deposit upon that side having been banked against the ice and left at the angle of repose by the removal of the ice support. The southern slope is usually gentle and uniform. This difference is seen clearly by looking eastward to Cobb's hill from the "Pinnacle." The presence of much till in the range, especially upon the north slope and summits, is significant. Heavy boulders occur upon the very crest of the "Pinnacle," and the southern ridge of Cobb's hill is a mass of remarkably heavy boulder till. The disturbed, crumpled and crushed condition of the beds along the north slope indicates a pushing or overriding by readvance of the ice front. The beds along the north side dip steeply southward into the range, and

*Vol. 2, pages 181-200, February, 1893.

while there is considerable variation, with as much eastward as westward dip, the general direction of inclination is southward or across the range.

During the time of the deposition of these hills, vast glacial waters were held south of the ice sheet in this region, having at first their outlet westward to the Mississippi but with final escape eastward to the Mohawk. The Pinnacle hills were accumulated in these waters as shown by the following characters :

The deposits throughout the range are mainly waterlaid drift, coarser upon the north side and grading into fine sand upon the south side and into clay upon the plain beyond. These finer deposits upon the southern flank of the range are quite horizontal and undisturbed and must have been deposited in standing water. Large boulders occur in the fine deposit, which signify flotation by ice.

These hills rise only 100 to 200 feet above the Rochester plain, and are conspicuous because of their isolation. They are however the only heights within several miles of the city, and an appeal is made for their preservation, since they are being destroyed for building materials. Their practical use for reservoir sites, etc., is exceeded by their æsthetic value. As part of the park system and the people's pleasuring ground they would be of inestimable value to the inhabitants of the future city, and the city officials and people of this day will receive and merit the condemnation of posterity if measures are not taken to preserve the hills from destruction.

The lecture was illustrated by maps and lantern views.

In the discussion of the paper remarks were made by H. C. Maine, A. C. Allen and Emil Kuichling urging the importance of preserving the "Pinnacle Hills." The following resolutions offered by Professor S. A. Lattimore were unanimously adopted :

WHEREAS, The range of hills on the southern border of the city of Rochester, popularly known as the Pinnacle hills, constitute a natural feature of our landscape, remarkable alike for the pleasing diversity which their outline, rising boldly from the plain, gives to the environment of our city, and also for their wonderful geological formation, being, in fact, the unique relics and monuments of a period antedating by cycles the pyramids of Egypt and all other human structures, whose strange and instructive history is recorded in their strata of sand and gravel, and of which the paper of Professor Fairchild constitutes so valuable an elucidation, and

WHEREAS, These are the only hills within a radius of several miles of the city of Rochester, from whose heights the whole plain of the city, the beautiful region toward the north, and even the blue horizon of Lake Ontario are in full view, and so are of inestimable value for both scientific and æsthetic considerations, and

WHEREAS, The unrestrained cutting away of these hills for the purpose of obtaining building materials is rapidly defacing and destroying them, and already threatens the highest point, called the Pinnacle; therefore

Resolved, That it is the sentiment of this Society that public opinion should be aroused to the value of these hills to the city of Rochester, and to the danger that threatens their existence; and,

Resolved, That in the opinion of the members of this Society, the Pinnacle Hills throughout their whole extent should become a part of the system of public parks of Rochester, which in connection with the Genesee river, its cataracts and the canyon, would thus include a matchless combination of natural scenery ; and further be it

Resolved, That to secure immediate attention to this subject these resolutions be transmitted to the Common Council, the Board of Park Commissioners, to the Chamber of Commerce and to the Historical Society.

MAY 13, 1895.

The President in the chair. Twenty-five persons present. The Council report was adopted which recommended (1) The payment of a bill for janitorial services. (2) The election of the following persons as active members of the Society, under suspension of the rules :

PROFESSOR HENRY E. LAWRENCE,
MRS. AUGUSTA B. GOULD,
MISS EMMA E. ILES,
MR. CHARLES H. POTTER.

The following paper was read :

THE COLEOPTEROUS FAUNA OF ROCHESTER AND VICINITY.

BY RICHARD M. MOORE, M. D.

The paper was illustrated by charts, diagrams and specimens.

MAY 27, 1895.

Vice-President J. M. DAVISON in the chair. Sixty persons present.

MR. H. K. PHINNEY exhibited fragments of charred wood found beneath four and one-half feet of drift in a sewer excavation in Dartmouth street.

The fifth and last lecture of the Popular Lecture Course, illustrated by charts and lantern views, was delivered by the President, as follows :

GLACIAL LAKES OF WESTERN NEW YORK.

BY PROFESSOR HERMAN LEROY FAIRCHILD.

[ABSTRACT.]*

This paper was a description of the waters held at high level in the north and south valleys between the receding front of the great ice sheet and the north-sloping land surface. The plateau of central and southwestern New York is deeply trenched by ancient stream erosion, some of these valleys now holding the so-called "Finger" lakes. Each of the trenches, whether now impounding water or not, was, during the ice retreat, the site of a lake having as its northern barrier the ice front and with its outlet southward across the divide into southern drainage. The height of these ancient glacial lakes was that of the lowest col or pass at the head of the valley, usually some hundreds of feet above the present valley bottom. The channel cut by the draining stream appears on the southern side of each col and at corresponding heights along the valley slopes are found the deltas built in the lakes by the inflowing streams.

To distinguish the ancient ice-dammed lakes from the existing lakes in the same valleys the former are named after the chief towns in the basins, or by prefixing the term "glacial." For example, the glacial water in the head of the Seneca valley is called Watkins lake, and it had its outlet through the site of Horseheads to the Chemung river, with an altitude of 900 feet, or toward 500 feet above the present Seneca lake. The ancient lake in the Canandaigua valley is Naples lake ; in Keuka valley, Hammondsport lake ; in Cayuga valley, Ithaca lake ; in Skaneateles valley, glacial Skaneateles lake.

*The substance of this address is published in the Bulletin of the Geological Society of America, Vol. 6, pages 353-374, April, 1895, with six plates.

The paper described a series of these lakes in the several valleys, extending in a belt from the Tonawanda valley on the west to the valleys in the region of Syracuse on the east, with their phenomena and life history. These lakes expanded northward with the ice recession and were destroyed by the opening of outlets across the east or west borders lower than the original southward outlet. Those lakes with higher levels were lowered to adjoining lakes of lower levels, and all were eventually drained into and blended with the great glacial Lake Warren, which poured its waters westward to Mississippi drainage, and crept eastward along the ice front until it was also destroyed by draining east into the Mohawk.

During the life of the local lakes, Ithaca lake on the east and Hammondsport lake on the west were lowered to the level of the Watkins lake, which in its expanded state is called Lake Newberry. The latter met its extinction by draining westward into Lake Warren at a point five miles southeast of Canandaigua village, soon blending with the larger water.

JUNE 10, 1895.

The President in the chair. Fifty persons present. The Council report was adopted which recommended the payment of certain bills.

Under suspension of the rules JOHN J. HEVERON and A. E. DUMBLE were nominated and elected active members.

MR. ADELBERT CRONISE gave a lecture illustrated by lantern views entitled :

A MONTH IN THE HAWAIIAN ISLANDS.*

JUNE 24, 1895.

The President in the chair. Seventy-five persons present.

The President announced that this meeting, according to the usual custom, would be held under the direction of the Botanical Section; and the Vice-Chairman of the Section, Miss Florence Beckwith, assumed the chair.

*This address is published with illustrations in the Commercial Travelers' Home Magazine, Vol. VI, pp. 1–18, January, 1896.

Miss Beckwith spoke of the different exhibits, calling particular attention to some of the more rare and interesting species of native plants in the large collection.

PRESIDENT FAIRCHILD read for the author the following paper :

A MEMORIAL SKETCH OF CHESTER DEWEY, M.D., D.D.

BY CHARLES W. SEELYE.

The subject of this notice was born at Sheffield, Massachusetts, in 1784. In 1806 he graduated at Williams College and then studied for the ministry, and was licensed to preach in 1808. The same year he accepted a tutorship in Williams College and in 1810 was appointed Professor of Mathematics and Natural Philosophy in the same institution, and held this office for seventeen years.

During this time he discharged the duties of his position not only acceptably but with great credit to himself, and promoted the standard of scholarship. From 1827 to 1836 he was at the head of the Gymnasium at Pittsfield, a boys' high school. During this last period, or a portion of it, he was also Professor of Chemistry in the Medical College at Pittsfield, and at the same time held a similar professorship in the Medical College at Woodstock, Vermont.

In these years of active labor as an instructor he was devoting a portion of his time to botanical work, and prepared a "History of the Herbaceous Plants of Massachusetts," which was published by the State. He was also examining and making notes on the Carices, having commenced his "Caricography," his principal botanical writing, in 1824. In 1836 Dr. Dewey came to reside in Rochester as principal of the Rochester Collegiate Institute. In this position he displayed great ability, and organized and conducted the institution in a manner which gave it a wide and honored reputation in educational circles.

His great range of knowledge, and his simple and beautiful life, which appeared devoted to the welfare and uplifting of others, gained him universal respect among his fellow citizens, and his genial and sunny disposition endeared him to all who had intercourse with him. His direct influence reached not only his school pupils but extended to the whole community. By the request of citizens he frequently gave courses of popular lectures in the winter seasons on the subjects of Chemistry, Astronomy, Natural Philosophy and Geology and illustrated them with experiments, apparatus and charts. His role was

that of an educator, but his moral force was never latent or disguised. He was a frequent and acceptable occupant of the various Protestant pulpits of the city, but in the capacity of a moral philosopher rather than a preacher.

His influence for enlightenment and morality was felt throughout the community. He impressed upon his pupils the sacredness of natural law. In his estimation, if the writer may infer from the impression made upon himself as one of his pupils, theology and science walked hand in hand. More than once he has heard a class of young men advised in regard to their course of conduct in life to keep themselves in accord with nature's laws.

Botany was a favored subject in the school curriculum, and it was seldom that a class was lacking to receive his instructions. Up to the year 1850 farming lands and the virgin forests occupied a large portion of the present area of the city of Rochester and therefore the meadows and fields, woodlands and by-ways were easy of access, and the native plants were gathered by many eager collectors. In this way Dr. Dewey examined and re-examined many times the greater portion of the flora of this region, while at the same time he was training up the youth to share his interest in botanical pursuits. The influence which he thus exerted is still perceived by some of the members of the Academy of Science, and it has passed out and onward over a great region, so that a large number of the younger botanists of the present time owe indirectly to Dr. Dewey the interest which they now possess for botanical studies.

Up to the year 1847 the text book of botany in common use was that of Mrs. Lincoln, arranged after the Linnæan method, but Dr. Dewey, who had kept pace with botanical progress, did not allow his pupils to remain in ignorance of the new or natural method of grouping plants which was soon to supplant the old system, and the subject of the natural relations of plants was an important topic in connection with all class-room analyses. When Wood's Class-Book of Botany appeared, which was the first in this country with a flora arranged with the natural orders, it bore the inscription :

'To the Rev. Chester Dewey, M. D., D. D., Professor of Natural Science in the Berkshire and other Medical Institutions, Author of the Report on the Herbaceous Plants of Massachusetts, Monograph on the Carices, etc., etc.

THIS VOLUME
IS RESPECTFULLY DEDICATED, BY
THE AUTHOR."

In the preface the author says: "To the Rev. Professor Chester Dewey, to whom I am permitted to dedicate this volume, I am indebted for that part of the flora which relates to the difficult, yet deeply interesting, family of the Carices. He has not only granted me access to his former excellent monograph of that genus, but has prepared the article for the present work with his own hand."

In 1850 Dr. Dewey was elected Professor of Chemistry and Natural Philosophy in the University of Rochester, which position he occupied until 1860. After this time he still continued his studies and observations and maintained an interest in nearly all scientific subjects until his last days. He died in the eighty-third year of his age, beloved and respected by all who knew him.

In 1868 in connection with a notice of his death the following appeared in the American Journal of Science and Arts, 2 series, XLV. 123:

"Dr. Dewey was an early and a frequent contributor to this Journal upon several subjects, but especially upon that with which his name is inseparably connected—the Carices of North America. His Caricography, commenced in 1824, was continued year after year with few breaks, down to the close of 1866, when it terminated with a general index to species. It is not for us to speak particularly of the merits of this elaborate monograph, patiently prosecuted through more than forty years. This and the monograph of Schweinitz and Torrey laid the foundation and insured the popularity of the study of the Sedges in this country. But while the latter systematic arrangement was published as a whole in 1825, Dr. Dewey's, carried on without particular order, extended through a lifetime, and represents both the earlier and the later knowledge.

"Botany was one of the occupations of Dr. Dewey's leisure hours; his long life was mainly devoted to education. Turning his attention to a special yet almost inexhaustible subject, however, and laboring perseveringly and faithfully, although under many disadvantages, he has permanently and honorably impressed his name upon the science in which the Californian Umbelliferous genus *Deweya* records his services. He was an excellent, simple-hearted, devout man, a fine specimen of the Western New Englander of the old school.

"The lovers of Carex, so numerous in this country, will cherish the memory of these two venerable men, Sartwell* and Dewey, long associated in congenial pursuits and gone to their rest together.

*Dr. Henry P. Sartwell, of Penn Yan, N. Y.

"May the turf of the Sedges they loved, and which cover or ought to cover the low mounds under which their dust reposes, keep them perennially green, and adorn them each returning spring with their sober blossoms."

Following the reading of the Memoir, remarks were made by Professor S. A. Lattimore, the immediate successor of Dr. Dewey, upon the value of the latter's scientific work in the University of Rochester.

Mr. John Walton, whose exhibit of drawings of wild flowers occupied one side of the lecture hall, described his methods and spoke of the advantages of making drawings of plants from nature while pursuing the study of botany.

A collection of pressed ferns belonging to Mr. Charles W. Seelye was exhibited. The fronds, representing about 65 varieties, were all from *Asplenium filix-fœmina* Bernh., and showed great diversities of form. Mrs. J. H. McGuire, Recorder of the Section, called attention to this exhibit and read extracts from the minutes of the Botanical Section (Proc. Roch. Acad. Science, Vol. 2, pp. 238-239) describing these variations.

Professor Henry A. Ward exhibited and described some roots of the mandrake (*Mandragora autumnalis*) procured by him in Syria, which bore more or less resemblance to the human form, and spoke of the ancient fables which have been founded upon similar fancied resemblances.

Professor Charles Wright Dodge exhibited under the microscope a collection of local algæ. In describing them, Professor Dodge said that some of the specimens were of the same species as those which had recently given an unpleasant taste and odor to the Rochester water supply.

Mr. John Dunbar exhibited a large collection of cultivated plants and shrubs grown in Highland park.

A large display of wild flowers occupied a table in the center of the room and embraced most of the more interesting and rarer plants in blossom at this time. Among them were *Utricularia cornuta* Michx., *Calopogon pulchellus* R. Br., *Pogonia ophioglossoides* Nutt., *Sarracenia purpurea* L., *Drosera intermedia* var. *Americana* DC., *D. rotundifolia* L., *Potentilla palustris* Scop., *Nymphæa odorata* var.

minor Sims., and *Arceuthobium pusillum* Peck. The latter was found at Mendon Ponds by Mr. M. S. Baxter, the only station reported in this county.

The formal meeting adjourned at an early hour in order to permit the audience to examine the collections.

October 14, 1895.

The meeting was held in the Lecture hall of the Reynolds Library, the President in the chair. Forty-eight persons present.

The Council report recommended: (1) The payment of a bill. (2) The election as corresponding members of Dr. Anna H. Searing and Dr. Frederick Starr. (3) The election as Fellows of

Mr. M. W. Cooke,
Dr. George W. Goler,
Dr. Charles T. Howard,
Miss Ada M. King,
Dr. J. H. McCartney,
Mr. J. Y. McClintock,
Mr. H. K. Phinney,
Mr. J. E. Putnam,
Mr. F. W. Warner.

The bill was ordered paid and the corresponding members formally elected; the nominations for fellows were laid upon the table, under the rules.

Dr. George W. Goler, as special committee on place of meeting, made an informal report to the effect that arrangements had been made with the Reynolds Library for the free use of the room in which the Society was then convened, and that the Council had chosen this as the place of regular meeting until further notice.

The following letter was read by the President:

October 14, 1895.

Mr. Herman LeRoy Fairchild,
President of the Rochester Academy of Science.

Dear Sir—As the result of a number of years' collecting, exchange, and purchase, I have accumulated a collection of pressed specimens of ferns, of both native and exotic species. A portion of these specimens are mounted on white cardboard 11½ x 16½ inches, the standard herbarium size.

Of North American ferns there are 108 mounted specimens comprised in 23 genera; of exotic species there are 552 mounted specimens in about 130 genera. Besides the mounted specimens there is a considerable number yet unmounted,

both native and foreign, including a collection of the ferns of Colorado and the ferns of Great Britain, the total number being nearly or about 900.* The collection, examination, study, and preparation of these specimens have been for many years an unfailing source of interest and information, It is my desire that this collection shall pass into the possession of the Academy of Science for the use of its members, and I now offer it to the Academy for this purpose. The collection contains most of the Sandwich Island ferns and the ferns of Australia, and many specimens from various parts of the world, such as New Zealand, South Africa, India, Ceylon, South America, Jamaica, and some of the West India islands, and elsewhere. The whole is encased in a black walnut cabinet.

The specimens still unmounted I shall endeavor to mount in the same manner as the others, and I hope still to add many more to them.

Some books and publications relating to the *filices*, and which are named in a list below, and now form a part of my library, I also convey by this writing to the Academy.

LIST OF BOOKS.

Historia Filicum, by John Smith.
The Ferns of North America, by Daniel C. Eaton, containing 81 colored plates.
The British Ferns, by Sir William Jackson Hooker, containing 65 colored plates.
Synopsis Filicum, by Hooker and Baker.
The British Ferns, by George W. Johnson, F. R. H. S.
Our Native Ferns and their Allies, by Underwood, fourth edition, revised.
The Fern Garden, by Shirley Hibbard.
Ferns in their Homes and Ours, by John Robinson.
Hand Book of the Jamaica Ferns and their Allies, by G. S. Jenman.
The Hand Book of Jamaica, containing a list of Jamaica Ferns.
An Atlas to the Coal Flora of Pennsylvania and of the Carboniferous Formations throughout the United States, by Leo Lesquereux, containing numerous plates of the fern flora of the Carboniferous era.
Hawaiian Ferns, by Edward Bailey.
The Ferns of Kentucky, by John Williamson.

Yours very respectfully,

CHARLES W. SEELYE.

The President remarked upon the importance and value of this gift to the herbarium of the Society, and said that appropriate action upon the matter would be taken at a future meeting.

The Librarian reported the addition of about 100 volumes and pamphlets to the Library during the summer.

The following paper, illustrated by maps and charts, was read :

*Subsequent study of the collection by Mr. M. S. Baxter showed that the total number of specimens was nearly 1,500. See report of Curator in Botany at Annual Meeting, January 9, 1900.

THE LACUSTRINE HISTORY OF THE GENESEE VALLEY.

By HERMAN LEROY FAIRCHILD.

(Abstract.)*

The Genesee Valley has a slope from its head in Pennsylvania to Lake Ontario of about 2000 feet. During the Glacial period the receding ice front formed a barrier which obstructed northward the drainage we find at present. The waters, not only from precipitation but derived from the melting ice body, were consequently impounded in the valley south of the glacier and forced into some southward outlet. In the lake history ten stages were described. During the four earliest stages the outflow was to the Allegany river—Mississippi system; the latest and largest of the outlet channels being at Cuba, N. Y., traversed by lines of railway. The fifth and sixth stages correlated with the great channel past Arkport and Hornellsville and contributed waters to the Susquehanna system. The seventh stage had outlet westward across the divide in the neighborhood of Bethany, N. Y., to the great glacial Lake Warren which poured its waters past the site of Chicago to the Mississippi. The eighth stage was the level of Warren waters which invaded the region and occupied the valley up as far as Mt. Morris and Dansville. The ninth stage was Lake Iroquois, with its shore line at the "Ridge Road" and its outlet to the Mohawk—Hudson. This ninth (Iroquois) stage was the last of the glacial waters in the valley, as the tenth or Ontario stage is non-glacial.†

The several water levels have left conspicuous evidences in their eroded outlet channels, deltas of inflowing streams, etc.

All the rock cuttings or ravines in the valley are post glacial, showing diversion of the streams from their preglacial channels which had been filled with drift. The largest examples are the canyons of the Genesee at Portage, Mt. Morris and Rochester. The history of the glacial waters, with the stream activity, is a complex but fascinating and romantic story.

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*The substance of this paper, with map and illustrations, is published in the Bulletin of the Geological Society of America, Vol. 7, pages 423-452, April, 1896.

†Since the above was written the author has discovered phenomena of another water plane below the Warren and above the Iroquois. This was first described as the Geneva Beach in Bull. Geol. Soc. Am. Vol. 8, pp. 281-284. In a later paper, in Bull. Geol. Soc. Am. Vol. 10, p. 56, the water body was called Lake Dana and was correlated with the outlet channel leading southeast from Marcellus village. It was a long pause in the lowering of the hypo-Warren waters by eastward escape to the Mohawk. In the lake succession in the Genesee valley Lake Dana is the ninth stage, making Iroquois the tenth stage.

OCTOBER 28, 1895.

The President in the chair. Twenty-seven persons present.

The announced program of the meeting included reviews in several departments of science.

Professor S. A. LATTIMORE described the newly discovered element Argon, and discussed its nature, its utility, and the manner in which it was discovered.

Professor CHARLES WRIGHT DODGE described some recent experiments by Professor Howells, of the University of Michigan, with reference to the production of the different forms of blood corpuscles.

MR. H. L. PRESTON exhibited and described some newly discovered minerals.

Professor A. L. BAKER discussed some of the aspects of modern mathematical concepts.

NOVEMBER 11, 1895.

The President in the chair. Thirty-one persons present.

The Council report was adopted, which recommended:

(1.) The payment of certain bills. (2.) The election of the following candidates as active members: VICTOR J. CHAMBERS, SAMUEL P. MOULTHROP, FRANKLIN H. BRIGGS. (3.) The election of the following persons as Life Members: MR. CHARLES W. SEELYE, on account of his gift to the Society of his collection of ferns, and REV. JOHN WALTON, on account of his gift to the Society of a collection of local mollusca.

The nomination of certain members as Fellows, which had been presented by the Council October 14 and laid over one month, under the rules, was taken up and the nominees were duly elected.

MR. H. L. PRESTON exhibited some specimens of stalagmitic limestone and so-called Mexican onyx showing mammillary and botryoidal structure.

The following paper, illustrated by material, was read:

DESCRIPTION OF SKULLS OF THE CLIFF DWELLERS OF ARIZONA AND NEW MEXICO.

By Charles H. Ward.

Several persons participated in the discussion of the material.

The following paper was read by the President :

KAME AREAS OF WESTERN NEW YORK.

By Herman LeRoy Fairchild.

(Abstract.)*

This paper was a description of areas of sand or gravel in the region south of Irondequoit and Sodus bays. The largest in area is that occupying the upper part of the Irondequoit valley. South of this, and essentially a portion of it, lies the Victor kame area, with the highest hills in Monroe County. Another interesting area of kames is in the southern part of Monroe County, west of the Irondequoit valley, surrounding the Mendon ponds. The other large area described in the paper lies north of Geneva and includes the Junius ponds.

These localized accumulations of water-laid drift were piled at the ice front during the rapid melting and recession of the glacier by the streams flowing out of the glacier, and mostly in the standing water of the glacial lakes which bathed the ice front.

November 25, 1895.

Held in Anderson Hall, University of Rochester. The President in the chair. Forty-seven persons present.

The following paper was read, illustrated by charts and preparations under the microscope :

THE EVOLUTION OF THE CELL THEORY.

By Charles Wright Dodge.

Following the paper the members were invited to inspect the charts and microscopic preparations.

Mr. Charles H. Ward exhibited a copy of a French work on Anatomy which bore upon the fly leaf the signature of Theodore Schwann, the father of the cell theory.

*The substance of this paper is published in the Journal of Geology, Vol. IV, pages 129-159 Feb.-Mar., 1896, with maps and photographs.

DECEMBER 9, 1895.

The President in the chair. Twenty-six persons present.

The Council report was adopted, which recommended :

(1) The payment of certain bills. (2) The change of the days of meeting from the second and fourth Mondays to the second and fourth Tuesdays of each month, until the summer recess.

Letters were read from Mr. Charles W. Seelye and the Rev. John Walton acknowledging their election as life members.

The following paper was read :

SOME PHASES IN THE CARE OF THE INSANE.

BY EVELINE P. BALLENTINE, M. D.

The paper was discussed by several persons.

JANUARY 14, 1896.

SEVENTEENTH ANNUAL MEETING.

The President in the chair. Forty persons present.

The Council report was adopted, which recommended the payment of certain bills.

The reports of officers for the preceding year were declared in order.

SECRETARY'S REPORT.

The report of the Secretary, PROFESSOR A. L. BAKER, is summarized as follows :

Number of meetings held during the year, 19 ; number of papers read, in Geology, 5 ; in Geography, 2 ; in Zoölogy, 2 ; in Mathematics, 2 ; in Hygiene, 2 ; and one each in Engineering, Mineralogy, Botany, Biology, Economics. Total, 18. This list includes only formal, announced papers.

Number of active members elected, 45. Two corresponding members elected and three transferred from active membership. Two life members elected from active membership. Fellows elected, 10.

Corresponding Secretary's Report.

The Corresponding Secretary, Professor Charles Wright Dodge, reported as follows :

The work of the Corresponding Secretary, as heretofore, has consisted during the past year in the distribution of the copies of the Proceedings and the receipt of publications sent by other societies in return. The labor of wrapping and addressing the Proceedings has been performed by the Librarian, to whom credit should be given. The amount of correspondence relating directly to this office has been small, but has been given such attention as it demanded.

Respectfully submitted,

Charles Wright Dodge,
Corresponding Secretary.

Treasurer's Report.

The Treasurer, Mr. F. W. Warner, made only a verbal report showing the favorable state of the treasury, with a balance on hand of $110.00.

Librarian's Report.

The report of the Librarian, Miss Florence Beckwith, was read as follows :

Since the report read at the Annual Meeting, January 14, 1895, the list of accessions to the library up to March 1, 1895, has been published in Brochure 4, Volume 2, of the Proceedings of the Academy. The list as published contained 1146 volumes and pamphlets.

The library has been constantly growing, and up to January 1, 1896, there have been added 300 volumes and separate publications, distributed among different countries as follows :

United States	104	Holland	2
Canada	12	Italy	13
Mexico	6	Luxembourg	1
Central America	3	Norway	1
South America	1	Portugal	4
West Indies	1	Roumania	1
Austria and Hungary	10	Russia	15
Belgium	16	Sweden	2
France	22	Switzerland	7
Germany	31	Japan	1
Great Britain	12	Australia	5

Contributed by authors..... 30

Very many valuable scientific publications are included in this number.

Respectfully submitted,

FLORENCE BECKWITH,

Librarian.

REPORT OF THE BOTANICAL SECTION.

Read by MRS. J. H. MCGUIRE, Recorder of the Section.

The officers of the Botanical Section are: MISS MARY E. MACAULEY, Chairman; MISS FLORENCE BECKWITH, Vice-Chairman; MRS. J. H. MCGUIRE, Recorder.

The Section has met regularly once in two weeks at the house of Mr. William Streeter, No. 14 Scio street. Twenty-five meetings have been held during the year.

Extracts from the Minutes of the Section.

February 7, 1895. The Section was entertained by Mr. Streeter, who gave a microscopical exhibit of Hemlock water filterings. Among the objects shown were *Fragilaria*, *Euglena*, *Pandorina moreum*, *Asterionella* and others. He also exhibited longitudinal and cross sections of *Pinus Strobus* L., showing the pitted vessels and fibro-vascular bundles. The bast fiber in a piece of macerated wood was also shown.

February 21, 1895. Mr. Streeter continued the study of Hemlock filterings, showing a number of forms of diatoms. The tissues of various plants were also examined.

March 28, 1895. Mr. Streeter resumed the study of Algæ, showing *Pediastrum*, *Scenedesmus*, *Pandorina*, and other species.

April 12, 1895. The topography and flora of Mendon ponds were discussed.

April 25, 1895. On motion it was voted to pay particular attention to the collection and study of *Carices* and grasses during the summer.

May 20, 1895. Mr. Baxter exhibited *Salix myrtilloides* L., *Carex limosa* L., *Scheuchzeria palustris* L., *Arceuthobium pusillum* Peck and *Viola tricolor* var. *arvensis* Hook. from Mendon.

Miss Beckwith exhibited a curiously distorted, gnarled, and intertwined twig of *Berchemia*, presented to the Section by Mr. C. W. Seelye.

June 3, 1895. Mr. Dunbar exhibited several species of exotic

roses under cultivation at Highland Park ; also specimens of pine, showing the stages in the development of fruit occurring in three consecutive years.

July 1, 1895. Dr. Frederick Starr, of Chicago University, by request, spoke on the flora of Mexico, giving some account of a recent visit by him to that country, and saying that it was a wonderful and unworked field for botanists.

Mrs. J. H. McGuire showed *Symphytum asperrimum* Sims, the first time it has been reported in this district.

July 15, 1895. Miss Beckwith reported a new station for *Phlox subulata* L. near Maxwell's station, Livingston county. She also reported finding *Solanum Dulcamara* L. with white blossoms in the same locality.

Mr. Baxter exhibited a plant of *Brasenia peltata* Pursh, not in bloom, from Bushnell's Basin.

August 12, 1895. Mr. Baxter reported *Magnolia acuminata* L. and *Poterium Canadense* Benth. and Hook. at Fisher's station.

Miss Macauley and Miss Beckwith reported *Aster Novi-Belgii* var. *elodes* Gray and *Gerardia purpurea* var. *paupercula* Gray, at Mendon.

August 26, 1895. Miss Beckwith exhibited a "double-flowered" form of *Ranunculus acris* L., found by her in the same place where it had been found by Mr. Fuller thirteen years ago, and *Polygonum sagittatum* L. having peduncles armed with fine, saw-toothed prickles.

September 23, 1895. Miss Beckwith showed specimens of *Aster Novæ-Angliæ* L. with variations in color from nearly white through pink to dark purple.

October 7, 1895. Miss Beckwith showed *Hyssopus officinalis* L. from Pinnacle Avenue.

October 25, 1895. Mr. Baxter brought a twig of *Quercus bicolor* Willd. upon which were eleven leaves presenting a great variety of form. Specimens of hickory nuts were shown by different members, making an interesting study. A typical *Carya sulcata* Nutt. was shown by Mr. Laney.

Miss Beckwith reported a new station for *Geranium pusillum* L. on Monroe avenue near Laburnum crescent.

Mr. Fuller gave some interesting observations on *Acer saccharinum* var. *nigrum* Torr. and Gr., which he had made during the season.

November 8, 1895. Mr. Baxter exhibited a quantity of acorns, and a number of typical forms of *Quercus bicolor*, *macrocarpa*, and *prinus*, were examined.

November 22, 1895. Mr. Dunbar exhibited specimens of seeds of five species of birch, American white, European white, black, yellow, and canoe.

Botanical Curator's Report.

The Academy is fortunate in being again the recipient of large additions to its collection of plants.

Mr. C. W. Seelye, who has made the study of ferns a specialty for many years, has generously presented to the Academy his extensive and valuable collection of American and exotic species, embracing about 900 specimens, many of them rare and nearly all new to our herbarium.

During the past season, members of the Botanical Section have added many specimens of phanerogams.

The herbarium account now stands as follows: Number of mounted specimens, 4295; number of unmounted specimens, over 5300; making a total of about 9,600.

Respectfully submitted,

J. B. Fuller,
Curator in Botany.

Report of the Engineering Section.

Read by Mr. J. Y. McClintock, Recorder of the Section.

At a meeting of the Academy held in the Chamber of Commerce on January 21st an organization was made of an Engineering Section by twenty-two gentlemen present. Mr. Emil Kuichling was elected chairman, and Mr. J. Y. McClintock Recorder, and the proceedings were approved by the Academy of Science on January 28th. On this same date Robert Cartwright was elected First Vice-Chairman and Wm. E. Hoyt Second Vice-Chairman. The membership increased to fifty. Meetings were held on January 28th and on February 4th. By-Laws were adopted on the latter date.

George W. Rafter related interesting incidents of a recent trip in Europe and described the present condition of practice in disposal of sewage and garbage, and of building bridges over canals. An animated discussion followed the paper.

February 18th: Robert Cartwright gave a very interesting and instructive talk, illustrated with black-board sketches, on the "Evolution of Steam Navigation," which was made effective by numerous illustrations drawn from his personal experience in designing and operating marine engines during a period antedating the introduction of the screw propeller and covering active service in the Navy during the Civil War.

March 4th: J. Y. McClintock read a paper on "City Bridges." The paper covered the subject in general and referred particularly to bridges proposed by him for Exchange Street and West Avenue over the Erie Canal. The paper was supplemented with forty lantern views showing the tendency of European practice, and also showing definitely the plans proposed for this city, one being a lift bridge resting on submerged pontoons for Exchange Street, and an overhead fixed bridge for West Avenue. The discussion was participated in by Messrs. Rafter, Jordan, Mosscrop, Kuichling and others.

Mr. Jordan presented a plan for Exchange Street providing for counterweights below the roadway, and for making the bridge of the least possible weight by using plank flooring and providing bearing posts in the center of the canal attached to the bridge so that when raised they fold up against it, so as to be out of the way of boats. The subject was continued to next meeting.

March 18th: Mr. McClintock explained in detail his manner of estimating the necessary force for operating his bridge with submerged pontoons.

Mr. Kuichling brought in a German engineering paper which showed that as early as 1888 the plan of applying submerged floats or pontoons was suggested for a canal lift to take the place of locks. The discussion was continued by Messrs. Kuichling, Mosscrop, Skinner, Fisher and Rafter.

April 1st: Upon reading of the minutes Mr. Kuichling said that they should be amplified so as to show, what was the fact, that he had presented the German periodical, not to show that the idea of pontoons as applied to lift bridges by Mr. McClintock was not original, but rather to endorse the practicability—by showing that it had been urged for application to far more important works, and that he believed the idea to be original with Mr. McClintock as claimed by him, although the record showed that it had been originated previously for other applications, and that Mr. McClintock was entitled to credit for conceiving the plan.

William F. Jordan read a very interesting paper on "Stone Masonry," illustrating upon the blackboard the methods employed to determine the stability of retaining walls and for proportioning same, and also describing experience on the Buffalo, Rochester and Pittsburg R. R. in repairing defective masonry piers by filling with cement grout. The paper was discussed by Messrs. Cartwright, Skinner, Brotsch, Kuichling, Fisher, Thompson, Munger, Story, Raymond and McClintock.

April 14th: Mr. Kuichling spoke of the death of Mr. John Bisgood, Engineer of the Western Division of the Erie Canal and a member of the Section, and on motion of Robert Cartwright the following resolutions were adopted:

"*Resolved*, That by the death of John Bisgood we are deprived of an esteemed associate member, who was a good citizen, a sympathetic friend, a warm hearted comrade, a considerate chief, an entertaining companion, an experienced civil engineer and an honest man, and it is fitting for us to note upon our records this tribute of respect, together with an outline of his life.

"*Resolved*, That a copy of these resolutions be sent to the family of our deceased member and associate, and be published in the daily papers of this city, and entered upon the records of the Rochester Academy of Science."

John Bisgood was born in Ireland 72 years ago. He came to this country when 18 years old, locating at Albany, and securing a position as draughtsman in the office of the state engineer. From then to the time of his death he was employed upon the state canals, excepting the years when he was in the army.

Mr. Bisgood did his duty as a patriotic citizen by serving with distinction during the Civil War as a member of Company A, Third New York Cavalry, and was present at all the engagements in which his regiment took part.

His ability as an engineer was recognized by gradual promotion, and for the past five years he has been division engineer of the New York state canals.

Gaylord Thompson read a paper describing the Otis Elevating Cable Railway up the eastern slope of the Catskill Mountains, 7,000 feet long with a rise of 1,630 feet and maximum grade of 34 per cent. The paper was especially instructive in showing how the inclination of slope could be so varied that the pull of the down cars would vary as the weight of the counterweighting cable and car diminish. Remarks were made by Messrs. Kuichling, Cartwright and Jordan.

May 6th: Edwin A. Fisher read a paper on the "Story of a Canal Changed into a Railroad," being a carefully prepared and valuable paper upon the Genesee Valley Canal which was displaced by the present Western New York and Pennsylvania R. R. The paper was most interesting and contained the record of much valuable experience as to train resistance of curves and grades, and length of life of wooden bridges and railroad ties, also practical methods of increasing strength of wooden bridges to accord with increased weight of rolling stock. The paper was illustrated with plans and diagrams and by photographs taken by Mr. C. R. Neher.

May 20th: Frank L. Dodgson read an instructive paper on "Railway Signals," especially showing the development of the latest improved interlocking systems.

June 3rd: Informal meeting and discussion.

July 10th: About a dozen members of the Section made an excursion to Syracuse and enjoyed a very beautiful day in examining street improvements and the new distributing reservoir, with a drive to Warner's and an inspection of the works of the Empire Portland Cement Co., also taking in on the way the Wm. A. Sweet Steel Works.

Since that date no meetings were held until January 6th, 1896, when a meeting was held and devoted to conversation, more especially upon electricity.

A resolution was adopted asking the Academy to print in their proceedings such papers as were prepared for this Section and corrected for publication by their authors.

Election of Officers.

The annual election of officers of the Society for the ensuing year was held with the following result:

President, Herman LeRoy Fairchild.
First Vice-President, J. M. Davison.
Second Vice-President, J. Eugene Whitney.
Secretary, Arthur Latham Baker.
Corresponding Secretary, Charles Wright Dodge.
Treasurer, F. W. Warner.
Librarian, Miss Florence Beckwith.
Councillors, { Adelbert Cronise, J. Y. McClintock, } *until 1899.*

The following paper was read:

THE SANITATION OF ROCHESTER.*

By George W. Goler, M. D.

This paper was illustrated by charts showing the prevalence of various diseases in different parts of the city during a series of years.

January 28, 1896.

The meeting was held in the Physical Laboratory, University of Rochester.

The President in the chair. Twenty-four persons present.

The following paper, with lantern illustrations, was read :

MEASUREMENT OF HIGH TEMPERATURES.

By Henry E. Lawrence.

February 11, 1896.

The meeting was held in the hall of the Chamber of Commerce.

The President in the chair. Forty persons present.

The Council report was adopted, which recommended :

(1) The payment of certain bills. (2) The election of Mr. D. L. Covill as active member. The appointment of the following Curators :

In Biology, Charles Wright Dodge.
In Botany, Joseph B. Fuller.
In Conchology, John Walton.
In Entomology, Charles T. Howard.
In Geology, Clifton J. Sarle.

The President announced that the scientific program of the meeting was to be held under the direction of the Engineering Section.

The chair was then assumed by the Chairman of the Section, Mr. Robert Cartwright.

The following paper was then read :

*An abstract of this paper is printed in the Rochester Democrat and Chronicle, January 15, 1896.

THE ELECTRICAL EQUIPMENT OF A MODERN COMMERCIAL BUILDING.

By Joseph E. Putnam.

The paper was illustrated by the electrical appliances used in lighting, heating, ventilating and supplying power to the Chamber of Commerce building.

Following the reading of the paper the members were conducted through the building to inspect the various electrical apparatus.

February 25, 1896.

The President in the chair. The usual audience present.

In the absence of the Secretary, Mr. H. L. Preston was appointed Secretary *pro tem.*

Mr. J. M. Davison exhibited an unusual form of quartz from Greenfield, Saratoga county, New York. This was a nodular and radiated mass, the size of a chestnut, derived from a Laurentian gneissoid rock which had been altered by contact with a dyke. Its hardness 6 to 7, infusible, opaque before blowpipe, partly decomposed in HCl. without gelatinizing. The analysis yields quartz 93.75, alumina 6., with a trace of iron and water.

Mr. Preston thought the mineral was probably a pseudomorph of quartz, perhaps one of the zeolites, which frequently occur in radiated forms.

The President exhibited a picture of a fossil neuropterous insect of gigantic size.

The following paper was presented :

ANALYSIS OF THE KESEN METEORITE.

By J. M. Davison.

This meteorite, which fell in the village of Kesen, Japan, on the 13th of June, 1850, is described by Prof. Henry A. Ward in the Proceedings of this Academy for 1892, Vol. 2, Brochure 2, p. 171.

The analysis here given was completed after the publication of

Prof. Ward's paper, three separate determinations being made.

1st. Of the portion soluble in HCl.

2nd. Of the portion insoluble in HCl.

3rd. Of the metallic portion separated from the mass by the magnet.

From these analyses that of the entire mass was calculated.

The percentage of nickel (10.05) in the metallic portion is above the average.

	Entire Mass. (computed.)	Soluble in HCl. 31.68	Insol. in HCl. 51.79	Metallic. 16.53
SiO_2	36.24	7.35	64.15	.....
Fe	13.00	.....	.....	87.22
Fe_2O_3	18.04	45.32	6.97	.....
Al_2O_3	3.34	1.63	5.35	.....
P_2O_5	0.36	0.10	..... (P.)	0.12
Ni	2.13	2.00	.....	10.05
Co	0.12	0.17	.....	0.46
CaO	2.35	1.68	3.49	.....
MgO	22.54	41.58	17.80	.....
S	1.53	0.19	.....	1.56
Na_2O	0.34	.....	1.27	.....
K_2O	0.01	.....	0.05	.....
	100.	100.02	99.08	99.41
Less O. for S		.10		
		99.92		

Rochester, N. Y., Jany., 1894.

The following paper was read by MR. E. G. BARNUM:

THE PINNACLE PEAT MARSH.

BY H. L. FAIRCHILD AND E. G. BARNUM.

Within the limits of the city of Rochester is an interesting peat marsh apparently in a state of nature, and covered with a forest growth which may be primeval. It occupies one of the numerous depressions or basins found in the Pinnacle hills, and is situated about forty rods east of the South Goodman street extension through the ridge. In shape it is oblong or oval with its longer diameter east and west. Its dimensions are about three hundred feet east and west by

one hundred forty feet north and south. An abrupt high bank extends from the west end around the south side. The northern bank is lower with a more gentle slope, and separates the peat marsh from a lakelet on the northwest, near Goodman street, and from one still smaller directly north.

The unobservant eye would probably see nothing unusual or interesting in this depression, as the surface is covered with a growth of yellow birch and herbaceous plants, such as grow in moist woods. Investigation, however, reveals the interesting fact that the material beneath the forest mold is a deep accumulation of peat which has undoubtedly filled the basin once occupied by a morainal lake.

In the autumn of 1895 the attention of the class in Physical Geology of the University of Rochester was directed to this marsh, and an investigation of the deposit was made by the junior author, assisted by Mr. R. B. English and Mr. C. J. Sarle. On October 22d, 1895, a small excavation was made by shoveling out the peat to a depth of thirteen feet. From the bottom of this pit a pole was thrust and driven twelve feet deeper. At this point it was evident that something more solid than the peat was reached by the end of the pole. Assuming the obstruction to be the bottom of the depression would give the peat a thickness of at least twenty-five feet.

Below the plane of partial oxidation the peat is of a reddish yellow or dull straw color when first removed. It is mainly coarse in texture, showing distinctly its fibrous structure and vegetable origin. The vertical section of the deposit is quite uniform in appearance, with the exception of three narrow bands. Two of the latter, made up of small brownish sticks or woody rootlets, are about three inches thick and occur at a depth of three feet four inches and six feet respectively. The third streak occurs at depth of eight and one-half feet. This is darker in color and finer grained than the rest of the mass, and seems to be the result of greater decomposition at that point.

At a depth of six feet was found a pebble of quartzite. There was no trace of an opening having been made through which this might have fallen, and the peat fibres curved around it in such a way as to indicate that it had been dropped into the bed when the peat was forming at that plane, and previous to the laying down of the superincumbent mass. It seems not unreasonable to attribute the occurrence of the pebble to human agency, as the upper six feet of vegetable accumulation may have formed since the occupation of this region by the aborigines. At nine feet below the surface was found

what was believed to be, from examination made at the time, a seed of the basswood. Unfortunately this was broken in the examination and the parts lost. At six feet eleven inches was found a stick about one and one-half inches in diameter, with the bark intact, which was supposed to be a branch of yellow birch. At a depth of about ten feet, and extending obliquely downward, occurred a tree limb about four inches in diameter. This was identified by Professor W. W. Rowlee, of Cornell University, from specimens sent him, as *Acer rubrum*. Several specimens of peat were also sent to Professor Rowlee, who reported that the specimen taken from a depth of nine feet contained leaves and stems of the large cranberry (*Vaccinium macrocarpon*). These stems penetrate to some extent throughout the mass. Perhaps the two streaks of stems and roots mentioned above are the result of the cranberry having had complete possession of the bog at periods corresponding to those layers. It may also be added that Mr. Gardiner, who has charge of the grounds containing the marsh, states that he has dug cranberry plants from this bog for shipment.

Professor Rowlee also states that intact specimens of the roots of a sedge (probably *Carex filiformis*) were found in the peat, and that the minute fibers which are so abundant as to be the main material are the vascular elements of similar rootstalks.

An analysis of the peat made by Mr. Edward Hirshfield for the percentage of absorbed moisture and ash gives the following results:

	Moisture.	Ash.
Specimen A, from surface,	14.47%	2.15%
" B, " a lower depth,	14.23%	3.05%
" C, " still deeper,	14.51%	5.08%

The basin occupied by this peat marsh is of the kind characteristic of glacial deposits, and known as "kettles." The form and relation of the ridges surrounding the basin together with the depth of the latter suggest that it was probably the locus of a buried ice block.

The ridges about the basin are gravel and sand, but evidently the bottom and walls are of less pervious materials. The bottom may not be far above the limestone rock and must be floored by either rock or till. The basin was probably at first a lakelet with level perhaps below the present top of the marsh. Higher accumulation of the peat seems to have been prevented by the inability of the basin

walls to permanently retain the water at any higher level. That water stands for a time over the marsh is proven by the growth of the birches which have all developed "knees" in order to carry the trunks above water.

The letter of Professor Rowlee is here appended.

ITHACA, N. Y., Oct. 28, 1895.

My Dear Professor Fairchild: I received your letter and also the box of specimens Saturday and have examined the material to-day.

The large piece from a depth of nine feet had leaves and stems of the large cranberry (*Vaccinium macrocarpon*). The leaves are so characteristic that I do not believe there can be any mistake about them. Although I did not find them connected with the stem, I feel very sure that the little brown sticks running through the mass are cranberry stems, they have such a fixed habit of sending out superimposed roots at their nodes.

The minute fibers running all through the mass are the vascular elements of the rootstocks and roots, a few of which occur intact in the specimen. These are from a species of sedge, I think, but just which species I do not certainly know. All the circumstances point to its being *Carex filiformis*, a plant which now is one of our most effective bog-builders.

Here, as in other specimens, I have been surprised in not finding organized remains of sphagnous moss. In no case yet have I yet found it in specimens taken from considerable depth. It seems to wholly decompose and disintegrate.

The block of wood from a depth of eight feet is *Acer rubrum*.

The specimens from eleven feet have, so far as I can see, the same materials as those from nine feet. Oxidation has blackened the fibers much more, however.

The specimen from nine feet has a large leaf which I cannot at present identify. Its margin is gone and the venation is not sufficiently preserved to be traced. It is pierced by numerous fibers which shows pretty conclusively that the fibers pertain to underground parts. * * * * *

Sincerely yours,

W. W. ROWLEE.

The following paper was read by the author:

A CITY'S NEGLECT OF A GREAT OPPORTUNITY.*

BY J. Y. MCCLINTOCK.

This paper dealt with two engineering problems prominently before the citizens of Rochester, namely: the enlargement of the section of the Erie canal through the city of Rochester, and the water storage of the Genesee river. The paper called attention to the necessity of the city safeguarding its own interest, and of anticipating any engineering plans which might be framed by the authorities to the detriment of the locality.

*The paper is published in full in the Rochester Democrat and Chronicle, February 26, 1896.

At the close of the paper, Mr. McClintock presented the following resolutions :

"*Resolved*, That the Rochester Academy of Science recommends to the Common Council that they should make an effort to secure the adoption of a plan for improving the Erie canal which will insure a sufficient supply of water without drawing upon the Genesee river, and which shall not make necessary the raising of the streets crossing over the canal in the city."

"*Resolved*, That the Rochester Academy of Science recommends to the Common Council that, in view of the difficulty of forming an intelligent opinion as to the best method of carrying through the project for controlling the flow of the Genesee river, it would be advisable to have a local commission to employ experts and report a plan for carrying it out in such a manner as to be of the greatest benefit to the whole community."

The paper and the resolutions gave rise to an animated debate. The resolutions were by vote referred to the Engineering Section.

MARCH 10, 1896.

The meeting was held in the Physical Laboratory, University of Rochester.

The President in the chair. One hundred five persons present.

The Council report was adopted which recommended :

(1) The payment of certain bills.

(2) The election as active members of the following candidates : JOHN H. FINNEY, HOWARD L. OSGOOD, GEORGE W. KNAPP, DANIEL D. TOMPKINS, GEORGE F. CHISM.

The following paper was read :

ROENTOGRAPHY—THE NEW PROCESS OF MAKING NEGATIVES.*

BY HENRY E. LAWRENCE.

The paper was illustrated by apparatus used in making the negatives, and by the making of actual prints of the human hand and other objects during the delivery of the paper.

*The paper is published in full in the Rochester Democrat and Chronicle, March 11, 1896.

MARCH 24, 1896.

The President in the chair. Thirty-two persons present.

Mr. C. R. Neher exhibited a specimen of flexible sandstone, itacolumite, from North Carolina.

Mr. J. G. D'Olier exhibited a number of grooved and perforated fragments of shale from Grand Isle, Vermont. There was some discussion over the objects, as to whether they were natural or artificial.

The following paper, illustrated by numerous examples, was read :

MINERAL PSEUDOMORPHS.

BY H. L. PRESTON.

The Rev. G. S. Robinson, of Scottsville, exhibited several curious tablets and other relics stated to have been found in ancient mounds in Michigan. The specimens gave rise to considerable discussion as to their genuineness and antiquity.

Mr. E. P. Clapp, of North Rush, exhibited a pipe found in excavation at Scottsville. The front of the bowl was ornamented with a human head, not of Indian type, and above the back of the bowl was the head of an animal, suggesting a wildcat.

Mr. A. E. Dumble showed a mound builder's pipe of stone, and a silver cross with a circular pendent shield engraved with the totem of a bear, found at Rice Lake, Canada.

The following paper was read by title :

PUFF BALLS, SLIME MOULDS AND CUP-FUNGI OF ORLEANS COUNTY, NEW YORK.

BY DR. CHARLES E. FAIRMAN.

Revised October, 1899.

The fungi enumerated in this paper were mostly collected at Lyndonville, N. Y. The list runs on consecutively from number 126 in my "Hymenomyceteæ of Orleans County," Proceedings Rochester Academy of Science, volume II, page 154.

The present list embraces species classed by mycologists under Gasteromyceteæ, Myxomyceteæ and Discomyceteæ. I have added a few Mucoraceæ found in this locality, although other Mucors have been seen but not specifically identified.

Some of the species are new to the State of New York, and one, viz.: *Tapesia Rhois*, is considered new to science. In the enumeration of the Gasteromyceteæ and Discomyceteæ the arrangement of Saccardo in the "Sylloge Fungorum" has been followed. A manual of the North American Discomyceteæ is sadly needed. Many of the species now recognized need careful revision and elimination. Cooke's list was published in 1875 and is not up to date. (Cooke, "Synopsis of the Discomycetous Fungi of the United States," Bull. Buffalo Soc. Nat. Sc.)

Delay in the printing of this paper has given me opportunity to revise the Myxomyceteæ in accordance with the "North American Slime-Moulds" of Prof. T. H. Macbride (Macmillan, 1899.)

GASTEROMYCETEÆ.

Family 1. PHALLOIDEÆ.

Sect. 1. PHALLEÆ.

A. PHALLEÆ MITRATÆ.

ITHYPHALLUS Fries.

127. **Ithyphallus impudicus** (L.) Fries. Peck, 28th Rep., page 85. Stink-horn, so-called from its very offensive odor. Figured in Wood's "Reference Handbook of the Medical Sciences," vol. 3, page 273, and Zopf, Die Pilze, page 381. Flats along Johnson's Creek, Yates, Oct. 1888.

B. PHALLEÆ CAPITATÆ.

MUTINUS Fr.

128. **Mutinus caninus** (Huds.) Fr. The superior part of the stipe is of a beautiful peach-blossom color. Near barns, Lyndonville. Uncommon.

Family 2. NIDULARIACEÆ.

*Peridium lacerate at the apex (not operculate).

NIDULARIA Fr.

129. **Nidularia pulvinata** (Schwein.) Fr. Peck, 30th Rep., page 51. Chestnut or bay-colored Nidularia. On wood in wood piles, Lyndonville, August, 1886. Peck found it in October on old fence boards. (Zopf in Die Pilze, page 378, gives the genus habitat as "alte Baumstümpfe und Hölzer"). Rare. Both Prof. Peck and Mr. Ellis assure me that this fungus is uncommon in this country.

* * Peridium with a deciduous operculum.

CYATHUS Hall.

130. **Cyathus vernicosus** (Bull.) DeCand. Peck, 22nd Rep., page 90. Zopf, Die Pilze, Fig. 88. Bird's-nest fungus. (Nestfrüchtig Bauchpilz, Ger.) On the ground. Lyndonville. Uncommon.

CRUCIBULUM, Tul.

131. **Crucibulum vulgare** Tul. Peck, 22nd Rep., page 90. Bennett and Murray, Crypt. Bot., Figs. 327, 328. Zopf, Die Pilze, page 376. Little crucible fungus, from its resemblance to a chemist's crucible. On ground. Common.

Family III. LYCOPERDACEÆ.

Sub-Family 2. DIPLODERMEÆ.

GEASTER Mich.

132. **Geaster limbatus** Fr. Peck, 44th Rep., page 23. Morgan in "North American Geasters," Journal of Mycology, vol. 1, page 7. Trelease, "The Morels and Puff Balls of Madison, Wis.," page 109. Fringed Earth-star. Under hedge rows, Lyndonville.

Sub-Family 3. LYCOPERDEÆ.

BOVISTA Dill.

133. **Bovista pila** B. and C. Peck, 30th Report N. Y. State Museum, page 49. Trelease, "The Morels and Puff Balls of Madison," page 111, and Plate VII., Fig. 6. Our specimen has the peridium smooth, shining, black. Trelease says, loc. cit., that it "is excellent eating when gathered young and properly cooked." On ground in pastures, Lyndonville. Not common.

LYCOPERDON Tourn.

134. **Lycoperdon gemmatum** Batsch. Peck, 22nd Rep., page 88. Trelease, loc. cit., page 114. Wood's "Reference Handbook Med. Sc.," page 281. Figured by Trelease, loc. cit., Plate VIII., Fig. 1. Warty Puff Ball.

135. **Lycoperdon Wrightii** B and C. Peck, 22nd Rep., p. 88. Trelease, loc. cit., page 114, and Plate VII., Fig. 8. Wright's Puff Ball. Spiny Puff Ball. Lyndonville.

136. **Lycoperdon pyriforme** Schaeff. Peck, 22nd Rep., page 88. Trelease, loc. cit., page 115, and Plate VIII., Fig. 5. Pear-shaped Puff Ball. Common on buried sticks. Zopf, Die Pilze, page 371, says that this is the most common representative of the Puff Balls in Germany.

137. **Lycoperdon hirtum** Mart. Peck, 46th Report, page 29. Prof. C. H. Peck refers our specimens to this species and says "scarcely different from Lycoperdon atropurpureum Vitt., with which it was united in my article on U. S. Lycoperdons, except in its cord-like root." Lyndonville. Uncommon.

138. **Lycoperdon Bovista** Linn. Lycoperdon giganteum Batsch and Lycoperdon Proteus Sow. are synonyms. Peck, 23rd Report, page 53. Trelease, loc. cit., p. 113. Excellently illustrated in Peck, 23rd Rep., Plate I., Fig. 1. Also fig. in Wood's "Reference Handbook," vol. 3, fig. 1373, and in Rep. Dep't of Agric., 1885, Plate II., Fig. 11. Everywhere known as Giant Puff Ball. In pastures and along fences, often attaining a large size. Taylor, Rep. U. S. Agric. Dept. says it grows "in great abundance on Genesee Flats in Livingston County, New York." Said by mycologists from all countries to be edible when young, white and creamy. Thus, Vittadini from Italy sings its praises. Zopf from Germany says "essbar und wohlschmeckend." (Die Pilze, p. 371.) Cooke, an English authority, says it is an excellent addition to the breakfast table, and Peck, N. Y. State Botanist in 23rd Report says "its edible qualities have been by no means overestimated." A more extended notice of this Puff Ball may be found in Prof. Peck's article on "Edible and Poisonous Fungi of N. Y." in the 48th Report, and a fine full page plate illustrating this species accompanies the article. The smoke of burning Puff Balls is used for stupefying bees. For their hemostatic and anæsthetic properties the reader may consult the "National Dispensatory," Art. Lycoperdon.

MYXOMYCETES (Link) DeBary.

(Slime Moulds.)

B. SAPROPHYTES.

a. With free spores, - - - - EXOSPOREÆ.
b. Spores in receptacles, or sporangia, - MYXOGASTRES.

Sub-Class EXOSPOREÆ Rost.

CERATIOMYXA Schröter.

139. **Ceratiomyxa fruticulosa** (Müll.) Macbride. Macbride, N. A. Myx., page 18, plate I., figs. 7 and 7 *a*. *Ceratium hydnoides* A. and S. in Peck's 26th Rep., Page 78. Common on moist, rotting wood.

Sub-Class MYXOGASTRES (Fries) Macbride.

MYXOMYCETES proper.

Order I. PHYSARACEÆ.

FULIGO (Haller) Pers.

140. **Fuligo ovata** (Schaff.) Macbr. Macbride, loc. cit., p. 22, plate X., fig. 2, 2*a*, 2*b*. *Fuligo varians* Sommf. in Peck, N. Y. Myx., 31st Rep., p. 57. *Fuligo septica* (Link) Gmel., in Sacc. Syll., vol. VII., page 353. On stumps in an apple orchard, Lyndonville, July, 1889.

PHYSARUM (Pers.) Rost.

141. **Physarum contextum** Persoon. Macbride, loc. cit., page 31, plate IX., figs. 3 and 3*a*. Peck, 31st Rep., p. 55, 46th Rep., p. 30. Sacc. Syll., vol. VII., p. 342. Lyndonville, June, 1889.

TILMADOCHE (Fries.) Rost.

142. **Tilmadoche alba** (Bull.) Macbr. Macbride, loc. cit., page 58. *T. nutans* Pers., in Peck, N. Y. Myx. 31st Rep., page 55. Sacc. Syll., vol. VII., p. 359. In *Sphagnum* woods, Yates, June, 1899.

LEOCARPUS (Link) Rost.

143. **Leocarpus fragilis** (Dickson) Rost. Macbride, loc. cit., p. 81, plate VIII., figs. 3, 3*a*, 3*b*. Peck, N. Y. Myx., 31st Rep., p. 56. Sacc. Syll., vol. VII., p. 358. (*Diderma vernicosum* of some). On bark, Lyndonville, June, 1889.

DIDYMIEÆ.

DIDYMIUM (Schrad.) Fr.

144. **Didymium Fairmani** Saccardo. Fairman in Notes on New or Rare Fungi from Western N. Y., in Jour. of Mycol., vol. V., page 78. Also in Proc. Roch. Acad. Sci., vol. I., p. 78, with plate 3, figs. 7, 8, 9. On under side of leaves of *Unifolium Canadense* (Desf.) Greene, false lily-of-the-valley, Ridgeway, N. Y., Aug., 1886. The larger portion of the original collection was sent to Prof. P. A. Saccardo, Padua, Italy, for identification, and having mislaid the fragment which I retained, I was unable to send Prof. Macbride a specimen for revision. For this reason this Didymium is not in Prof. Macbride's N. A. Myxomycetes.

Order II. STEMONITACEÆ.

STEMONITIS (Gleditsch) Rost.

145. **Stemonitis fusca** (Roth) Rostafinski. Macbride, loc. cit., p. 115. Peck, N. Y. Myx., 31st Rep., p. 56. Sacc. Syll., vol. VII., p. 397. Bennett and Murray, Crypt. Bot., fig. 334. On rotten logs, Lyndonville. Rather common. The peridia of this fungus drop off easily and leave nothing but a long, filiform, black stipe, which is seated on a common hypothallus, of a dark color. In this condition it looks like a mass of upright black hairs on a thin, black crust.

COMATRICHA (Preuss) Rost.

146. **Comatricha stemonitis** (Scop.) Sheldon. Macbride, loc. cit., p. 130 and plate VI., figs. 1, 1*a*, 1*b*, 3*c*, 3*d*. *Comatricha typhina* Roth. in Peck, N. Y. Myx., 31st Rep., p. 56. Sacc. Syll., vol. VII., p. 394. (*Stemonitis typhoides* DC. in Peck, 25th Rep., page 83.) Peck found it on rotten stumps. Berlese in Sacc. Syll., vol. VII., p. 395, gives its habitat as rotten wood. I found it at Lyndonville in 1890 on horse manure.

Order III. CRIBRARIACEÆ.

C. TUBIFEREÆ.

TUBIFERA Gmelin.

147. **Tubifera ferruginosa** (Batsch) Macbride. Macbride, loc. cit., p. 157, and plate I., fig. 4; plate VII., fig. 8. Sacc. Syll., vol. VII., p. 406. Peck, 31st Rep., p. 56. This is *Tubulina cylindrica* (Bull.) var. *acuta* Peck in Fairman, Fungi of Western N. Y., Proc. Roch. Acad. of Science, vol. I., page 53. In the Sylloge Fungorum, loc. cit., the peridia are described as "apice rotundatis." The late Dr. George A. Rex wrote me as follows: "the form of Tubulina with acute apices is common with us, in fact we have Tubulina in shapes from flat to acute points." Prof. Macbride says that "the peridia are sometimes acuminate, and widely separate above. This is Persoon's *T. fragiformis*."

E. CRIBRARIEÆ.

CRIBRARIA (Pers.) Schrader.

148. **Cribraria tenella** Schrad. Macbride, loc. cit., p. 167, plate XVII., fig. 5. Sacc. Syll., vol. VII., p. 414. On hemlock logs, Lyndonville, 1890.

149. **Cribraria purpurea** Schrad. Macbride, loc. cit., p. 169. Peck, N. Y. Myx., 31 Rep., p. 56. Sacc. Syll., vol. VII., p. 413. On rotten log, Lyndonville, May, 1887. Easily recognized by its purple color.

150. **Cribraria vulgaris** Schrad. Peck, 32 Rep., page 38. Sacc. Syll., l. c., p. 414. On rotten wood, Lyndonville, June, 1888.

DICTYDIUM (Schrad.) Rost.

151. **Dictydium cancellatum** (Batsch) Macbride. Macbr., loc. cit., p. 172, plate I., figs. 6, 6*a*. *Dictydium cernuum* Pers., in Peck. N. Y. Myx., 31st Rep., p. 56. *D. cernuum* (Pers.) Nees in Sacc. Syll., vol. VII., p. 410.

Order IV. LYCOGALACEÆ.

LYCOGALA Micheli.

152. **Lycogala epidendrum** (Buxb.) Fries. Macbride, loc. cit., page 175. Peck, N. Y. Myx., 31st Rep., p. 57. Sacc. Syll., l. c., p. 435. Common on stumps in woods. Often seen in its early state on account of the bright scarlet color of the immature plasmodium.

Order V. TRICHIACEÆ.

B. PERICHÆNEÆ.

PERICHÆNA Fries.

153. **Perichæna corticalis** (Batsch) Rost. Macbr., l. c., p. 185, plate II., fig. I. Peck, N. Y. Myx., 31 Rep., p. 57. Sacc. Syll., l. c., p. 420. On bark of fire wood in piles, Lyndonville, 1886.

C. ARCYRIEÆ.

ARCYRIA (Hill) Pers.

154. **Arcyria nutans** (Bull.) Grev. Macbr., l. c., p. 191, plate II., fig. 6. Peck, l. c., page 57. Sacc. Syll., l. c., p. 429. On rotting fence, Lyndonville, June, 1889.

155. **Arcyria denudata** (Linn.) Sheldon. Macbride, l. c., p. 195, plate II., figs. 5, 5*a*. *Arcyria punicea* Pers., in Peck, l. c., page 57. Sacc. Syll., l. c., page 426.

E. TRICHIEÆ.

HEMITRICHIA Rost.

156. **Hemitrichia vesparium** (Batsch) Macbride. Macbride, l. c., p. 203. This is the well known *Hemiarcyria rubiformis* (Pers.)

Rost., under which name it was listed in Peck, l. c., page 56, and Sacc. Syll., l. c., page 447. On rotten log, May, 1888.

157. **Hemitrichia clavata** (Pers.) Rost. Macbr., l. c., page 206, plate III., figs. 1, 1*b*. *Hemiarcyria*, Peck, l. c., page 56. Sacc. Syll., l. c., page 447.

TRICHIA (Haller) Rost.

158. **Trichia favoginea** (Batsch) Pers. Macbr., l. c., p. 214, plate IV., figs. 5, 5*a*, 5*b*. *Trichia chrysosperma* (Bull.) in Peck, l. c., page 56. Sacc. Syll., l. c., p. 442. On rotten wood.

159. **Trichia decipiens** (Pers.) Macbride. Macbr., l. c., p. 218. *T. fallax* Pers., in Peck, l. c., page 56, and Sacc. Syll., l. c., p. 439. On rotten log in woods, Lyndonville, Oct., 1899.

MUCORACEÆ DeBary.

Sub-Family 2. MUCORÆ Van Tiegh.

MUCOR Mich.

160. **Mucor Mucedo** Linn. Common everywhere on decaying fruit and vegetables, as well as various putrescent organic substances. For synonyms see Roscoe Pound, "Revision of the Mucoraceae," Minnesota Botanical Studies, Bulletin No. 9, page 93.

161. **Mucor Tæniæ** Fairman. Proc. Roch. Acad. of Science, vol. I, page 52, and plate IV., figs. 4, 5, 6. On segments of Tape Worm, Lyndonville.

RHIZOPUS Ehr.

162. **Rhizopus nigricans** Ehr. *Mucor stolonifer* Ehr. *Aseophora mucedo* Tode, in Pound's Revision, page 98. Name from the Greek *rhiza*, root, and *pous*, foot, i. e. root-footed, on account of the resemblance of the rhizoids to a root-system. For the same reason the fungus is called by the Germans "wurzelfuss." Nigricans —blackish, referring to the color of the sporangium, which becomes dark colored when the spores mature. For information as to structure and life history the reader is referred to: Underwood, "Moulds, Mildews and Mushrooms," p. 24, plate 2, fig. 3. C. J. Chamberlain, Jour. App. Micros., p. 547, fig. 26. Bennett and Murray, Crypt. Bot., p. 338. Zopf, Die Pilze, p. 316 and fig. 6. On grapes in baskets at the markets, Medina, N. Y., Jan., 1891. The appearance of the grapes was much injured by the fungus. Albert F. Woods, acting chief of the Division of Vegetable Pathology, U. S. Dept. Agric.,

wrote me as follows: "In regard to *Rhizopus nigricans* on grape, I have to say that it is very common not only on grapes which have been kept too moist and have thus started to decay, but also upon all other kinds of fruit. It is not strictly a parasite and I doubt whether it can be considered as at all parasitic, although after it starts on a bruised or broken berry it hastens decay. The only way to prevent it is to keep the berries dry and remove all broken berries."

DISCOMYCETEÆ Fr.

Fam. HELVELLEÆ Sw.

MORCHELLA Dill.

163. **Morchella esculenta** (Linn.) Pers. Peck, 28th Rep., p. 87, and 48th Rep., p. 124, plate III. Phillips, British Discomycetes, pages 3 and 4. Sacc. Syll. Disc., p. 8. Common Morel. Edible. Early spring.

Fam. PEZIZEÆ Fr.

ACETABULA Fr.

164. **Acetabula vulgaris** Fuckel. Phill. Br. Disc., p. 44. Sacc. Syll. Disc., p. 59. Sporidia elliptical, hyaline, 12-14 x 6-7 μ. Cellars. Lyndonville.

PEZIZA Dill.

165. **Peziza griseo-rosea** Gerard. Peck., 29th Rep., page 54. Sacc. Syll. Disc., p. 77.

SARCOSCYPHA Fr.

166. **Sarcoscypha coccinea** Jacq. Peziza, Peck in 23 Rep., p. 62. Lachnea, Phill. Br. Disc., p. 203. Early and beautiful. Woods, on sticks, etc. Yates and Ridgeway, common.

LACHNEA Fr.

167. **Lachnea scutellata** Linn. Pez. in Peck, 22 Rep., p. 94. Phill. Disc., p. 223. Sacc. Syll. Disc., p. 173. Common on rotten wood and buried sticks among leaves. Yates and Ridgeway.

HELOTIUM Fr.

168. **Helotium citrinum** (Hedw.) Pers. Sacc. Syll. Disc., page 224, Phill. Disc., p. 157. On under side of rotting fence rails, Yates, Oct., 1899. The cups are of a lemon-yellow color.

PHIALEA Fr.

169. **Phialea Urticæ** (Pers.) Sacc. *Hymenoscypha*, Phill. Br. Disc., p. 141. Sacc. Syll. Disc., p. 173. This is *Helotium fumosum* E. and E., Proc. Roch. Acad. Sci., vol. I, page 53. On dead stems of *Leonurus cardiaca* L. and *Arctium Lappa* L., occupying smoke-colored areas. Lyndonville.

170. **Phialea fructigena** (Bull.) Gill. Phill. Br. Disc., p. 135. Sacc. Syll. Disc., p. 265. In the cups of some oak. Ridgeway, Sept. 29th, 1891.

PSEUDOHELOTIUM Fuckel.

171. **Pseudohelotium Fairmani** (E. and E.) Sacc. Journal of Mycol., vol. IV., page 56. Sacc. Syll. Disc., p. 302. Proc. Roch. Acad. of Science, vol. I, page 52. On under surface of bark lying on the ground. Ridgeway, April, 1888, and Sept., 1899.

PEZICULA Tul.

172. **Pezicula rhabarbarina** (Berk.) Tul. *Patellaria* in Peck, 22 Rep., page 96. *Dermatea* in Phill. Br. Disc., page 343. Sacc. Syll. Disc., p. 311. On dead blackberry stems, Ridgeway, June, 1889. Rhubarb-colored, hence *rhabarbarina* from Rhabarbarum.

CHLOROSPLENIUM Fr.

173. **Chlorosplenium æruginosum** (Oeder) De Not. Peck, 24th Rep., p. 95 (*Peziza*). Phill. Disc., p. 147. The wood on which the plant grows is stained a deep verdigris-green color and is called in Germany "grünfaule," and in England "green oak." It is used in the manufacture of Tunbridge ware. This ware is made in Tunbridge, a town in Kent, England, of hard woods (cherry, beech, holly, etc.), inlaid and wrought into work-baskets, boxes, toys, etc. Our specimens were found on moist, fallen branches of hemlock, in swamps, May, 1895. The author has a block of cherry wood inlaid with a piece of the green wood from this specimen and finds that it takes a good polish, and concludes that the "green oak," as met with in this country, is also suitable for the manufacture of small articles of woodwork, similar to Tunbridge ware. The green coloring matter of *Chlorosplenium æruginosum*, or wood stained by it, is due principally to xylochloric acid. It can be obtained by extracting the green wood with chloroform, is slightly fluorescent, and according to Prillieux its spectrum shows three absorption bands, an intense one in the red, a less intense one in the orange, and one which occupies all of the

yellow. The pigment is not soluble in water, ether, benzine or alcohol. A second coloring matter, xylindein, has been isolated by Rommier. I have made some experiments with xylochloric acid as a stain for microscopic sections and find it unsatisfactory, the staining not being clear, uniform or well differentiated.

MOLLISIA Fr.

174. **Mollisia cinerea** (Batsch) Karst. *Pez.* in Peck, 28th Rep., p. 66. Sacc. Syll. Disc., p. 336. On dead limbs lying on the ground. March, 1898.

PYRENOPEZIZA Fuckel.

175. **Pyrenopeziza Tamaricis** (Roum.) Sacc. Sacc. Syll. Disc., page 371. On dead branches of *Tamarix Africana*, African Tamarisk, at Spring-brook Farm, the residence of Hon. M. L. Parker, Yates, N. Y. April, 1895. New to the State.

TAPESIA Pers.

176. **Tapesia sanguinea** (Pers.) Fuckel. Peck, 33rd Rep., p. 31. Sacc. Syll. Disc., page 371. Phill. Br. Disc., p. 281. On fallen branches. Woods. Lyndonville. May, 1887. The base of the fungus surrounded by a blood-red tomentum, and the wood on which it grows stained red. The red pigment is due to xylerethrinic acid (Bachmann), and is soluble in ether, alcohol, chloroform, etc., and does not afford a very characteristic spectrum.

177. **Tapesia Rosae** (Pers.) Fuckel. Peck, 43 Rep., p. 33. Sacc. Syll. Disc., p. 374. Phill., l. c., page 279. On stems of some wild rose. Yates.

178. **Tapesia Rhois** n. sp. Subiculum dark brown, broadly effused, felted, indeterminate; threads of the subiculum 3-4 μ long, unbranched, without conidia, brownish; cups scattered or gregarious, 1 to 2 millimeters broad, cup-shaped, then expanded and irregular; disc dull black to dark-slate color, with a silver-white margin; asci oblong clavate, 50 to 60 μ in length; sporidia hyaline, continuous, oblong, straight or curved, 7-13 x 2-3 μ. On fallen branches of Sumac, *Rhus glabra* L., Ridgeway, N. Y. May, 1895. The hymenium is occasionally pitted. This can be separated from pale varieties of *Tapesia fusca* by its simple, continuous sporidia, which are not guttulate, nor pseudo-septate, even when viewed with high powers (Bausch & Lomb 1-12). It is possible that the tapesium is formed of the altered substance of the inner bark.

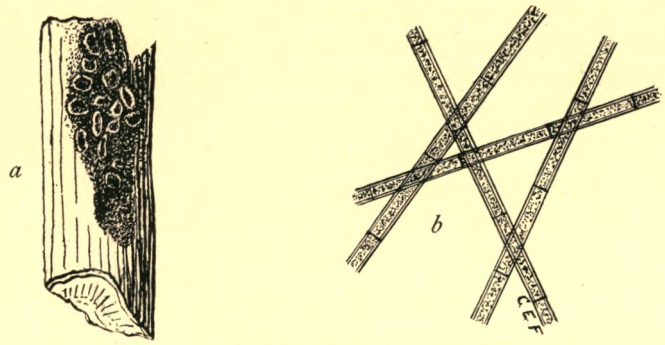

Fig. 1. *a*, Portion of branch with *Tapesia rhois*.
b, Threads of the subiculum.

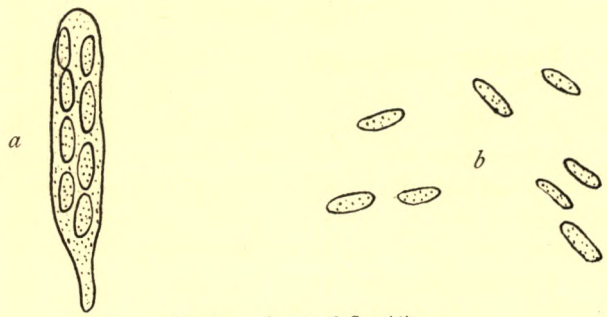

Fig. 2. *a*, Ascus; *b*, Sporidia.
Drawn with Gundlach ¼ in. obj.

Fig. 3. Sporidia more highly magnified.
Drawn with Bausch & Lomb 1-12 in. homogeneous immersion obj.

TRICHOPEZIZA Fuckel.

179. **Trichopeziza albo-lutea** (Pers.) Sacc. *Lachnella*, Phill., loc. cit., p. 259. Sacc. Syll. Disc., p. 412. On boards by the roadside. Yates. March, 1888.

DASYSCYPHA Fr.

180. **Dasyscypha virginea** (Batsch) Fuckel. *Pez.*, Peck, 23 Rep., page 62. *Lachnella*, Phill., l. c., p. 248. On rotting sticks and logs. Common.

181. **Dasyscypha nivea** (Hedw.) Sacc. *Pez.*, Peck, 25 Rep., p. 99. *Lachnella*, Phill., l. c., p. 245. On under surface of a board lying on the ground. Lyndonville, April, 1889.

182. **Dasyscypha fusco-sanguinea** Rehm. Sacc. Syll. Disc., page 459. On rotten wood. May 27th, 1890. Exterior brick-red when fresh.

183. **Dasyscypha clandestina** (Bull.) Fuckel. *Pez.*, Peck, 28th Rep., page 66. Sacc. Syll. Disc., page 457. On dead branches of *Ailanthus glandulosa* Desf. Our specimens are immature. Peck found it on dead stems of *Rubus strigosus*.

Section PHRAGMOSPORÆ.

ARACHNOPEZIZA Fuckel.

184. **Arachnopeziza Aurelia** (Pers.) Fuckel. *Pez.*, Peck, 34th Rep., p. 51. *Tapesia*, Phill., loc. cit., p .280. *Belonidium*, Sacc. Syll. Disc., page 499. On sticks under leaves, in the woods. Yates, May, 1889. On chips, dirt and burs of *Fagus Americana* Sweet. May, 1890. One of our most beautiful species. May be described as a phragmosporous Tapesia. The sporidia in our specimen were 18-20 x 6-8 μ.

Family ASCOBOLEÆ.

Section PHÆOSPORÆ.

ASCOBOLUS Pers.

185. **Ascobolus furfuraceus** Pers. Peck, 29th Rep., p. 56; specimen sent from Buffalo by Clinton. Phill. Br. Disc., p. 290. Sacc. Syll. Disc., p. 516. On cow dung in pastures. Yates, June, 1889.

Section HYALOSPORÆ.

LASIOBOLUS Sacc.

186. **Lasiobulus equinus** (Müll.) Karst. *Ascobolus pilosus* Fr. in Peck, 27th Rep., page 107. *Ascophanus* in Phill., l. c., p. 312. Sacc. l. c., p. 536. On cow dung in pastures, Lyndonville, June, 1889.

Family DERMATEÆ.

URNULA Fr.

187. **Urnula Craterium** (Schw.) Fr. Peck, 22nd Rep., p. 96. Sacc., loc. cit., p. 548. Woods. Somerset, Niagara Co., N. Y.

CENANGIUM Fr.

188. **Cenangium rubiginellum** Sacc. Sacc., loc. cit., page 560. On dead limbs of *Ostrya Virginiana* (Mill.) Willd. Ironwood. Lyndonville, June, 1890.

189. **Cenangium populneum** (Pers.) Rehm. *Dermatea fascicularis* in Peck, 22 Rep., p. 96. *Encœlia fascicularis*, Phill., loc. cit., page 336. Sacc. Syll. Disc., page 565. On dead limbs of *Populus sp.* Yates, April 28th, 1890.

190. **Cenangium Ellisii** Sacc. Sacc. Syll. Disc., p. 566. On dead limbs of *Benzoin Benzoin* (L.) Coulter.

TYMPANIS Tode.

191. **Tympanis Fraxini** (Schw.) Fr. Peck, 27th Rep., p. 108. Phill., l. c., page 355. Sacc. l. c., p. 581. On fallen branches of *Fraxinus*.

Family STICTEÆ.

PROPOLIS Fr.

192. **Propolis faginea** (Schrad.) Karst. *Stictis versicolor* Fr. in Peck, 29th Rep., page 56, where it is reported as sent from Buffalo by Clinton. *Propolis versicolor* in Phill., loc. cit., page 376. Sacc. Syll. Disc., page 648. Common on decorticated branches in the woods.

STICTIS Persoon.

193. **Stictis radiata** (Linn.) Pers. Peck, 25th Rep., p. 99. Sacc., loc. cit., page 682. *Schmitzomia* in Phillips, Br. Disc., page 380.

194. **Stictis stereicola** B. & C. Sacc., l. c., p. 695. On some *Stereum*, Ridgeway, July, 1890.

SCHIZOXYLON Pers.

195. **Schizoxylon æruginosum** Fuckel. Sacc. Syll. Disc., page 700. On fallen branches of oak, along the Ridge Road at Oak Orchard, April, 1890. On decorticated maple limbs, Yates, May, 1895.

Family PATELLARIEÆ.

LECANIDION Rab.

196. **Lecanidion atratum** (Hedw.) Rab. Peck, 31st Rep., page 51. Sacc. Syll. Disc., page 795. *Mollisia* in Phill. Br. Disc., page 181. On dead stems of raspberry, Lyndonville, June, 1889. On exposed roots of cherry, Rigdeway, May, 1895. Karsten found it on *Spiræa*. Ellis has almost always found it on herbaceous stems.

197. **Lecanidion indigoticum** (C. & P.) Sacc. *Patellaria* in Peck, 25th Rep., p. 98. Sacc., l. c., p. 797. On fallen branches, Oct., 1888. Easily recognized by the blue color of the crushed hymenium.

BLYTRIDIUM DeNot.

198. **Blytridium fenestratum** (C. & P.) Sacc. *Patellaria* in Peck, 28 Rep., p. 68. On bark of trees, Ridgeway, May, 1888.

Family GYMNOASCACEÆ.

EXOASCUS Fuckel.

199. **Exoascus deformans** (Berk.) Fuckel. Sacc., l. c., p. 816. See also Leaf Curl and Plum Pockets, by George F. Atkinson, Bulletin 73, Cornell Univ. Agric. Exp. Station, Sept., 1894. Causes the disease of the Peach known as Leaf-curl.

APRIL 14, 1896.

The President in the chair. Forty-two persons present.

The President was empowered to appoint some member to prepare a memorial of DR. S. A. ELLIS.

The following paper was read :

THE CLIMATOLOGY OF ROCHESTER.

By Orin Parker.

CONTENTS:

ROCHESTER RECORDS.

By climate we mean principally the conditions with reference to temperature, precipitation, cloudiness, sunshine and wind velocity and direction. Of temperature we have full records as to the highest and lowest for each day, and partial records as to the hourly distribution for twenty-five years; as to precipitation, the record is complete for observations and days and months, but it is incomplete as to hours; the record for the wind is complete as to velocity; partially as to direction, but embraces such a multitude of details it is very hard to handle. The record of cloudiness is complete in a manner and the sunshine depends, of course, in a measure on the cloudiness. The sunshine is greater than the complement of the cloudiness because at times the sun shines through thin clouds.

TEMPERATURE.

As to temperature, it may be said in a general way that this section enjoys moderation. Winters are milder and summers cooler than at some other places on the same latitude. The average annual temperature line is not deflected much by reason of the peculiar situation of Rochester, but warmth is delayed in the spring and lasts longer in the autumn than at places not under the influence and protected so fully by the lakes.

Averages; Comparison.

Taking Omaha for comparison, the yearly mean is 50° against 47° at Rochester; we find for March a normal of 30° at Rochester against 35° at Omaha; 43° for April, against 51° at Omaha; 56° for May, against 62° at Omaha. The delay in the autumn is shown by an average of 41° for November at Rochester, against 37° at Omaha; 29° for December, against 27° at Omaha.

Comparing temperatures of this place with places on nearly the same latitude east and west, with some departures on account of the interest attaching to special stations, we find as follows :

	Highest record.	Lowest record.	Highest monthly normal.	Lowest monthly normal.	Range, or amplitude.	Yearly mean.
Boston,	102	−13	72	27	45	49
New York,	100	− 6	74	31	43	52
Rochester,	99	−12	70	24	46	47
Buffalo,	94	−14	69	24	45	46
Chicago,	100	−23	72	24	48	49
Omaha,	105	−32	76	19	57	50
Los Angeles,	108	+28	72	53	19	52
San Francisco,	99	+29	61	50	11	57
Portland, Ore.,	99	+ 2	67	38	29	53
St. Vincent,	103	−54	66	6	72	34

In a report issued by the Weather Bureau in 1891 the highest temperature is given as 121°, at Yuma on September 8, 1886, and the lowest as −55°, at Havre on March 2, 1887.

Considering the temperatures at Rochester, without comparison, we find the maximum or highest day temperatures to average 56° for twenty-five years. The average is 51° for spring, 78° for summer, 60° for autumn and 33° for winter. The highest average for any ten days is 87° for the ten days ending September 16, 1892, and the lowest 12° for the ten days ending February 13, 1875. The highest average for thirty days is 83° for the thirty days ending August 17, 1892, and the lowest 20° for the thirty days ending February 23, 1895. The highest for any day was 99° on July 20, 1894, and the lowest maximum or coldest day, as distinguished from the night temperature or the average for the day and night, was 2° below zero on February 11, 1893.

The average of minimum or lowest night temperatures is 39° for the year, 35° for the spring, 59° for the summer, 44° for the autumn and 19° for the winter. The highest average for any ten nights is 68° for the ten nights ending July 18, 1876, and the lowest −4° for the ten nights ending February 13, 1875 ; the 30 warmest nights 66° ended July 28, 1887, and the coldest 30 nights 3° ended February 23, 1885. The highest daily minimum or warmest night occurred July 18, 1878, 76°, and the coldest had a record of −12° January 30, 1873, and February 13, 1875. The average yearly temperature, as given heretofore, is 47° ; the mean temperature for the spring is 39°, at Omaha it is 41° ; the mean temperature for the

summer is 67°, at Omaha it is 74° ; for the autumn it is 56°, at Omaha it is 52° ; for the winter it is 27°, at Omaha it is 24°.

As showing the mildness and lack of change at some places it may be stated in this connection that the spring averages 60° at Los Angeles, the summer 70°, the autumn 65°, and the winter 55° ; and as a marked example of severity of temperature and temperature changes St. Vincent with spring 35°, summer 63°, autumn 38°, winter zero. And so we might go on citing figures to show that Rochester comes in with severity in no direction as compared with other places, with summers that are cool, but not cold, and winters that are cold without severity. It may be of interest to look somewhat into the causes that govern these conditions. The modifying influence is found in Lake Ontario, principally, which takes in the heat of the sun in summer and gives it out again in winter, thus serving as a balance to keep conditions moving at all times in a groove not so far removed from the normal.

Heat Storage of Lake Ontario.

Lake Ontario is said to contain about 636 cubic miles of water, and the following calculation is based on this quantity. It is doubtful whether it can serve any useful purpose beyond exhibiting the massive grandeur of some of the forces in nature, for the figures are of such huge dimensions it is difficult to convey any definite idea of their magnitude. Let it be supposed that this body of water is reduced in temperature throughout 5° (the change may be much greater) and we find by calculation that the cooling of the waters would give forth as much heat as the burning of about 2,500,000,000 tons of coal ; or about five times the quantity mined yearly in the world. This heat, of course, is taken from the amount received from the sun during the summer and part of the spring and fall, and given out again during the cold season, when it is most needed.

For all the lakes the quantity of heat given off during the cold season probably exceeds that which would be derived from the burning of over 30,000,000,000 tons of coal. These aggregates, large as they are, are not sufficient, however, to entirely reverse the vast influence operating to produce heat and cold over this portion of the earth's surface. The provision is simply enough to prevent extremes of heat in summer and greater severity of cold in winter. As an example of this modifying influence, attention may be called to Omaha, with highest temperature of 105° and lowest of −32°, against 99° and

−12° for Rochester; and St. Vincent, which is, however, somewhat further north, with a maximum of 103° and a minimum of −54°. The Atlantic ocean is also near enough to occasionally modify to some extent both winter and summer temperatures.

Warm Waves.

As a rule warm spells are of home manufacture, meaning by this that they are generated over the interior of this country and not imported from beyond its borders. The conditions for their production are a quiescent state of the lower air, one in which there is no movement to mix the lower with the upper masses. They appear on the western face of a high pressure where the tendency of the force of the prevailing pressure is to bring the lower winds up from the South, and are usually located in the eastern half of a large and nearly forceless low whose center is somewhere over the West and moving slowly. Given these conditions and the production of warmth is certain at some place in the debatable land between the high and the low. One such warm spell at Rochester was the direct result of a cold wave that came in over the Northeast and held the lower air almost absolutely quiescent under its southwest quadrant, much as if the air were anchored in position. The heat of the sun was sufficient to heat up a thin layer near the ground to a high temperature in the course of about three days. Usually warm waves originate west of the Mississippi in the country where the rays of the sun reach the earth without being interfered with by cloudiness and gradually drift eastward frequently gaining while journeying.

Cold Waves.

With cold waves the facts are entirely different. No cold wave ever originates over this section. They are all importations. At long intervals cold appears to be originated over the Western plains, generally in Wyoming on the eastern slope of the Rocky mountains, but these spells are always of minor importance and seldom reach the dignity of what would be called real cold. Cold waves of importance appear to all originate in that portion of the continent north of the United States and east of the northern range of mountains. Their generation is conceived to proceed from the slow accumulation of a body of dry air over the region mentioned wherein the temperature is lowered principally by radiation from .the surface of the earth. That portion of the country is covered with ice and snow during the winter and radiation proceeds uninterruptedly. The air is dry because its moisture is removed in passing over the mountains to the westward by

the cold of elevation. The air comes in from the West from the general drift of the atmosphere from the west to the east up to about the 65th parallel.

When the cold wave is well formed the requirement for its transfer to the lower latitudes in force is to have a storm of energy form and pass to the east well south along the southern front of the mass of cold air. The road is then open and forces well disposed for its coming with speed and energy. Sometimes the storm does not respond to the necessities of the hour, in which case the north keeps its own until different dispositions of forces or the advance of the sun have time to mix up or destroy the severity. About the first of last January such a cold wave was met on the northern border of the United States by a powerful tendency toward warm which held it at bay for days and finally prevailed against it so that it never reached farther south. It was a huge affair with pressure above 31 inches and temperatures more than 50 degrees below zero.

Effect of the Lakes.

It is in the meeting of these cold waves that the lakes, with their vast stores of heat, become so important. Always in the early winter, and generally at all seasons, these cold waves split on the lakes, one detachment passing to the north and the other down over the west. The western detachment has so far to travel and is subjected to the influence of so much country relatively warm that even if forces operate exactly right for it to go south, only far enough to clear the lakes, and then northeast over this section, it does not get here with severity. The northern detachment is far more dangerous because its journey to the eastward north of the lakes is shorter and over a country so much colder ; the severest cold that reaches this section is from these northern detachments, but in this case even it requires a particular operation of forces not likely to work out very frequently. The cold can come in a tortuous course down over the Michigan peninsula, and across the Niagara strip without crossing much water. Severity has reached us by that route. The other combination is for the cold to forge eastward far enough to clear Lake Ontario, then move south to a point directly east, thence be pushed back over this section. This requires two changes of direction at about the right time, and is improbable in any particular case, but has worked out successfully. The cold of January 6, 1896, 10 degrees below zero, and the lowest of the winter, came in this way.

The lake stands always, so long as unfrozen, as a complete barrier

to the coming of severity from directly north or northwest. A more correct statement would, perhaps, be that it stands a complete barrier to the utmost severity being felt here, for the cold may pass overhead and strike further south. This is so, and must be so, because so long as the water is unfrozen the air in contact with it must take the temperature of the water, which cannot be much below 32 degrees, and this will heat up the lower layer which is felt here while the great cold may be passing over higher up. In such a movement the surface air must necessarily be from north to south, which brings the air of the lake surface directly on us.

PRECIPITATION.

As to precipitation, it may be said in a general way that, as with the temperatures, moderation prevails here. This place is not distinguished with high or low annual, monthly, seasonal or daily precipitation. The only place it reaches high rank in this connection is in the number of days rain or snow falls. Here it comes near the apex of experience in the United States. It takes somewhat high rank in the even distribution of precipitation through the months and seasons. No complete comparison of the departures from year to year can be given, but it is less here than most places. The average annual rainfall is about 34 inches against an average of 36 inches for the entire country. A sufficiently close comparison of seasonal with the average of the whole country is given elsewhere. The frequency of days with one-hundredth of an inch or more is supposed to be somewhat greater at Oswego than here ; outside of that one place Rochester holds the banner position. This frequency comes, however, largely from the fall of unimportant light lake snows during the winter.

The probability of rainy days ranges from 65 out of the hundred in January to 32 in August, against 41 in January to 33 in September at Boston and San Francisco ; 65 in January to 13 in August at Portland, Ore. In evenness our record is superb in both number of days and amounts per month and season. In normal for months the record here is from 3.34 inches in May to 2.44 in September, against 4.60 in November to 3 in September at Boston ; 4.80 in August to 3 in May at New York ; 3.80 in October to 2.40 in April at Buffalo ; 3.70 in July to 2.20 in December at Chicago ; 5.70 in July to 0.70 in February at Omaha ; 4.00 in February to trace in July at Los Angeles ; 5.30 in December to trace in July and August at San Francisco ; 8.00 in December to 0.60 in July and August at Portland ; 3.70 in July to 0.60 in January, February and November at St. Vincent ; 14.40 in

December to 2.10 in July at Tatoosh, Wash., and 0.60 in February and December to trace in May and January at Yuma, Arizona.

It will be observed that the range is less than at any other place except Yuma, where the greatest for any month is too small to permit of so much. Tatoosh and Yuma represent the highest and lowest rainfalls in so far as reported by the Weather Bureau. The average annual rainfall at Tatoosh is 89 inches while it is a little over 3 at Yuma. In a publication in regard to precipitation issued by the Weather Bureau, dated April 30, 1894, it is said that, it is a matter of interest to ascertain whether the rainfall at any particular place is due largely to small rains, or to great ones. If the former is the case it will generally be favorable to agricultural operations and lessen the injury from floods.

In order to ascertain the character of the rainfall tables have been prepared giving the percentage of days on which there was no rainfall, those on which the rainfall was between a trace and 0.25 inch, 0.25 and 0.50, 0.50 to 1.00, 1 to 2, 2 to 3, 3 to 5, and over 5 inches. These are all expressed in percentage of days on which such rain fell, and the months have been equalized so that the percentages show the relative times of rainfall, and also, with proper treatment, the relative quantity of rainfall of each kind. Examining this series we find four very distinct types as to the relative frequency of light and heavy rains. The first type is that which is found on the Lower Lakes, and which has its extreme at Oswego. Its especial characteristic is the relatively large number of days on which small rains fell. This number of days is often greater than those on which no rain fell. This is particularly the case with these rains in the winter, but it may extend in some cases through the year and at Oswego it is found that this maximum appears clearly in the annual rainfall curve.

It would be interesting to decide how much rainfall in a single day is damaging and how much beneficial. Undoubtedly the small rains, generally speaking, are beneficial and the heavy rains damaging. In frequency of small rains it will do no harm to read Rochester for Oswego. The greatest daily rainfall occurred in August, 1893, on the 19th, 4.19 inches. This is low compared with the extremes for many other places as, for instance, Alexandria, La., on June 15th and 16th, 1886, when over 21 inches fell. Helena, Ark., reports 12 inches in 40 hours; Hatteras, N. C., 9 inches in one day; New Orleans, 9; Fort Wallace, Kan., 9; Mayport, Fla., 14, and many other places nearly as much. In snowfall Rochester occupies a medium place, with about ten feet per year. There are much greater falls in north-

ern New York along the lower St. Lawrence and sometimes at Buffalo, and always over the upper lakes, particularly south of Lake Superior. To return to rainfall, including snowfall melted as a part part thereof, an examination of the records shows that the greatest average rainfall occurs during the ten days ending June 28th, during which 1.23 inches is the normal. The ten days ending June 8th is a close second, with 1.22, and also January 14th, with 1.21. The least rainfall occurs with 0.63 during the ten days ending August 7th, with 0.73 during the ten days ending February 4th as a close second.

The greatest rainfall for any ten days is 6.40 ending October 26th, 1873, and there have been eight instances of ten days passing without any fall whatever during the last 25 years. By 30-day periods the greatest average is the 30 days ending June 8th, in which 3.39 inches falls, and the least during the 30 days ending October 16th, in which the average is 2.35, showing a range in 30-day averages of only 1.04 inches.

The greatest rainfall for 30 days was in the 30 days ending November 15th, 1873, 9.20 inches ; the least, 0.20, November 15th, 1874. In percentage of days on which 0.01 or more precipitation occurs, the normal daily record varies from 67, January 18th, to 33, September 1st. The greatest 30-day record is 90 per cent., February 3, 1874, and the least 7 per cent., September 6, 1876. As to the distribution of rainfall through the year, 24 per cent. of the annual rainfall comes to Rochester during the spring, 26 per cent. during the summer, 24 per cent. during the autumn and 26 per cent. during the winter. At Boston the same record is 24, 24, 25, 27 ; New York, 24, 28, 24, 24 ; Buffalo, 21, 26, 28, 25 ; Chicago, 26, 30, 25, 10 ; Omaha, 28, 43, 26, 6 ; Los Angeles, 21, 2, 13, 64 ; San Francisco, 25, 0, 17, 58 ; Portland, 24, 6, 24, 46 ; St. Vincent, 20, 45, 23, 12. Rochester shows a variation of only 2 per cent. for the seasons, against 3 at Boston, 4 at New York, 7 at Buffalo, 11 at Chicago, 37 at Omaha, 62 at Los Angeles, 58 at San Francisco, 40 at Portland and 33 at St. Vincent.

An interesting point in this connection is the average rainfall for the entire United States. The average of all stations by states gives for spring about 9 inches, Rochester has 9 ; summer, 10, Rochester, 9 ; autumn, 8, Rochester, 8 ; winter, 9, Rochester 9 ; total yearly, 36 inches ; Rochester, 34. It appears that the rainfall over the United States generally is quite evenly distributed through the year, varying in total amount for the seasons from 10 inches for summer to 8 inches for autumn. The variation at Rochester is even less than this, being

only from 9 to 8. Generally the spring and summer rainfalls are the highest ; other things being equal, the rainfalls of spring and, next to that, of summer are the most useful for agricultural operations. At Rochester this statement becomes absolute.

With the depth given it is not difficult to get the average total rainfall for the entire United States, excluding Alaska. For this purpose we may take the average for each state and multiply it by the area of the state including water surfaces. Adding these together we get 1,407 cubic miles as the average annual total of water which descends as rain or snow in the United States. The annual depth of rainfall thus calculated is 29 inches, or less than that given by the other method. This is to be expected since the other method gave equal weight to each political division and these divisions are generally smaller in the regions of greater rainfall.

To get some conception of this enormous mass of water we may compare it with the contents of the great lakes and an approximate comparison is near enough. Lake Ontario contains about 636 cubic miles of water. The annual rainfall would fill it two times and leave something over for a third time.

Source of Moisture.

It is probable that the greatest source of water vapor supply for this section is the Gulf of Mexico, notwithstanding its great distance ; next in importance the Atlantic ocean, and lastly the lakes. The evaporation from the land is very largely carried out of the country by the easterly movement of the atmosphere during spells of dry weather. Large bodies of water produce vapor in great quantities continually and are producing as rapidly at the end of a dry spell when the land is pretty well exhausted. The machinery for bringing the vapor in from the oceans is found in the great storms which continually cross the country from west to east. In the eastern half of every storm the wind is from the south to the north and if the storm happens to be sufficiently large to reach well down over the Gulf, vast volumes of vapor are engaged and brought north to be precipitated over the country, sometimes far north of the border.

Coming from the Gulf of Mexico, the moisture-laden air is compelled to ascend to a much greater elevation and is exposed to mixture with bodies of cold air encountered in the journey and to loss of heat by radiation from the tops of clouds after they are formed. When a storm center passes south of this section masses of vapor from over the Atlantic are engaged in the northerly and westerly movement of

the eastern and northern quadrants of the storm, are brought inland, and are easily precipitated by elevation, radiation and mixture with cold air found over the lakes and along the borders. This is the mechanics of every heavy snowstorm whose history has been examined at this place.

CLOUDINESS.

In cloudiness, Rochester easily holds the lead, so far as records are available. It is great in amount and remarkably evenly distributed through the year. It is greatest in December with a normal of 83 per cent., and least in August with an average of 44 per cent., and the average for the year is 61 per cent. Compared with some other places, we find the same figures to be at Boston, 56 per cent. in December, 45 per cent. in August, and 51 per cent. for the year; Yankton, S. D., 51 per cent. in March, 39 in September, and 45 per cent.; San Francisco, 48 per cent. in January, 32 per cent. in October, and 42 per cent.; Portland, Ore., 72 per cent. in January, 35 per cent. in August, and 59 per cent. For the spring: at Rochester, the cloudiness is 58 per cent.; Boston, 54 per cent.; Yankton, 52 per cent.; San Francisco, 43 per cent.; Portland, 64 per cent. The summer: Rochester, 46 per cent.; Boston, 46 per cent.; Yankton, 42 per cent.; San Francisco, 43 per cent.; Portland, 64 per cent. Autumn: Rochester, 62 per cent.; Boston, 51 per cent.; Yankton, 41 per cent.; San Francisco, 35 per cent.; Portland, 55 per cent. Winter: Rochester, 78 per cent.; Boston, 53 per cent.; Yankton, 47 per cent.; San Francisco, 47 per cent., Portland, 72 per cent. Allowing 10 per cent. for sunshine through thin clouds and adding the complement of the cloudiness sunshine is 49 per cent. of the possible at Rochester, 59 per cent. at Boston, 65 per cent. at Yankton, 68 per cent. at San Francisco and 51 per cent. at Portland. Once during the past twenty-five years the cloudiness has been 100 per cent. for ten days, once 98 per cent., twice 96 per cent. and eleven times above 90 per cent., all except three occurring during the winter decades. The greatest for 30 days is 91 per cent. ending February 3, 1886, and the least 28 per cent. ending October 6, 1891.

WINDS.

In wind velocities Rochester is believed to hold about an average position. The most marked feature is found in the absence of tornadoes and very severe storms.

Remarks were made in discussion of the paper by Emil Kuichling, Professor A. L. Baker, J. E. Putnam, the President, and the author.

ADMINISTRATIVE PROCEEDINGS.

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SCIENTIFIC PROCEEDINGS.

Papers read, 1894–1896, but not printed.