PROCEEDINGS

OF THE

ROCHESTER ACADEMY OF SCIENCE

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OF THE

ROCHESTER ACADEMY OF SCIENCE, Rochester, N.Y.

VOLUME 1.

JANUARY, 1889, TO JUNE, 1891.

ROCHESTER, N. Y.
PUBLISHED BY THE SOCIETY
1891.

OFFICERS OF THE ACADEMY

1891.

President,	HERMAN LEROY FAIRCHILD
First Vice-President,	ALBERT L. AREY.
Second Vice-President,	EUGENE WHITNEY.
Secretary,	FRANK L. BAKER.
Corresponding Secretary,	GEORGE W. RAFTER.
Treasurer,	EDWIN E. HOWELL.
Librarian,	MARY E. MACAULEY.
Councilors,	FLORENCE BECKWITH, JOHN M. DAVISON, M. L. MALLORY, H. L. PRESTON, J. L. ROSEBOOM, WILLIAM STREETER.

Curators :

FLORENCE BECKWITH, in Botany.
CHARLES W. DODGE, in Biology.
JOHN WALTON, in Conchology.
GEORGE H. ASHLEY, in Geology.

Publication Committee :

H. L. FAIRCHILD, FRANK L. BAKER,
GEORGE W. RAFTER, M. L. MALLORY

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PROCEEDINGS

OF THE

ROCHESTER ACADEMY OF SCIENCE.

VOLUME I.

JANUARY 14, 1889.

TENTH ANNUAL MEETING.

In the Academy Hall, Reynolds' Arcade.

The President, Supt. S. A. ELLIS, in the chair.

A special committee, appointed at the previous meeting, to consider the matter of reorganization of the Society, presented a verbal report, recommending in substance, as follows: That the annual dues of the Society should be increased to five dollars; that the stated meetings should be held twice each month, and that the Society should publish its proceedings.

After discussion, the report was adopted.

It was voted that a special committee be appointed to revise the Constitution and By-Laws, and to report at a special meeting to be held at the call of the President. The committee was constituted as follows: S. A. Ellis, M. L. Mallory, Jas. E. Whitney, H. L. Fairchild.

The election of officers with all business of the annual meeting was postponed until the matter of reorganization should be determined.

Adjourned to meet at the call of the President.

1, PROC. ROCH. ACAD. OF SC., Vol. 1, May, 1890.

FEBRUARY 25, 1889.

SPECIAL MEETING.

Called by order of the President for the purpose of receiving and acting upon the Report of the Committee on Revision of the Rules.

The President, Supt. S. A. ELLIS, in the chair.

The committee, appointed January 14, to revise the Constitution and By-Laws, submitted the following printed report:

To the Rochester Academy of Science:

Your committee, charged with the duty of preparing a revision of the Constitution and By-Laws which should incorporate certain provisions, hereby submit their report for your consideration, including a printed copy of the proposed rules.

The committee feel that it is proper and desirable to summarize a few of the principal changes embodied in the revision, and the reasons therefor.

1. *Concentration.* It is believed to be desirable to unite the varied scientific talent of the city in a single, strong, comprehensive organization. The tendency of workers in similar lines to form associations by themselves is recognized, however, and the partial advantages of that plan are admitted. But it is believed that the Sections can be so related to the larger organization as to combine the advantages of both systems; and it is proposed to give the Sections sufficient liberty to enable them to privately carry on their special work, but at the same time to bind them closely to the general society. See chapter VII of By-Laws.

2. *Centralization of control.* To give the chief control, in all directions, to one General Committee, here called the Council, which will result in greater unity, harmony and permanency in the work of the society. The Council to be large enough to fairly represent all interests, and all Sections; the Special Committees to be responsible to the Council. See article VII of Constitution and chapter IV of By-Laws.

3. *Purposes of the Society.* The special objects of the Society to be accomplished by the reading and discussion of papers, the publication of scientific results, the exhibition of scientific material, the accumulation of a library and collections, and particularly the study of the Natural History of this region. See chapters VIII, IX and XI of By-Laws.

4. *Self-Support.* The membership charges to be high enough to give a modest support to the purposes of the Society, and the Publications to be distributed to the paying members. See chapters XI and XIII of By-Laws.

5. *Control of the Society.* By the establishment of the order of Fellows for the reception of the scientific members, and the keeping of the organization within their control, the latter may not be alienated from its purpose. See articles III, VI and VII of constitution.

M. L. MALLORY, *Chairman,*
S. A. ELLIS,
JAMES E. WHITNEY,
H. L. FAIRCHILD,
} *Committee.*

CONSTITUTION.

ARTICLE I.

NAME.

This organization shall be called the ROCHESTER ACADEMY OF SCIENCE.

ARTICLE II.

OBJECT.

The purpose of this society shall be to promote scientific study and research, and especially to gain and publish a thorough knowledge of the Natural History of that part of the State of New York in the vicinity of Rochester, and to make permanent collections of material in illustration of the Natural History of that region.

ARTICLE III.

MEMBERSHIP.

There shall be four classes of members, namely: Active Members, Corresponding Members, Honorary Members, and Fellows. *Active* members shall be such as reside in or near the city of Rochester; *Corresponding* members must be persons actively engaged in the cultivation of science and residing at a distance from the city of Rochester, and their number shall be limited to one hundred; *Honorary* members must be citizens of the United States and distinguished in science; their number shall be limited to seventy-five; *Fellows* shall be chosen from among the active members, in virtue of scientific attainments or services.

ARTICLE IV.

PRIVILEGES.

Only active members and fellows shall be entitled to vote or to hold office in the Academy.

ARTICLE V

ELECTION OF MEMBERS.

All members and fellows shall be elected by ballot, and the affirmative votes of three-fourths of the members and fellows present shall be necessary to elect a candidate. The names of candidates shall be proposed in writing, at least two meetings previous to balloting, and must receive the approval of the Council.

ARTICLE VI.

OFFICERS.

The officers of the Academy shall be a President, First Vice-President, Second Vice-President, Secretary, Corresponding Secretary, Treasurer and Librarian, who shall be chosen annually, by majority ballot, at the first stated meeting in the calendar year, and shall enter upon their duties at the next meeting. The President, Vice-Presidents and Secretaries shall be fellows.

ARTICLE VII.

COUNCIL.

The Council, by whom all business to be brought before the Academy shall ordinarily be prepared, shall consist of the officers of the Academy and six Councillors, of whom at least three shall be fellows.

The Councillors shall be elected by ballot at the first stated meeting after the adoption of this article; two to serve for one year, two for two years, and two for three years; and at every annual election thereafter two Councillors shall be elected to serve for three years.

Vacancies in the offices, or in the Council, occurring in the interval between the annual elections may be filled by special elections at a regular business meeting, provided notice of such election shall have been given at a preceding regular business meeting.

ARTICLE VIII.

QUORUM.

Ten members at an ordinary meeting shall form a quorum, and fifteen at a special or regular business meeting, a majority of whom in either case shall be fellows.

ARTICLE IX.

BY-LAWS.

By-Laws for the further regulation of the Society may from time to time be made.

ARTICLE X.

ALTERATIONS.

No alterations shall be made in this Constitution except by a two-thirds vote at two successive regular business meetings, after full notice of the proposed changes or amendments, and the date of voting, shall have been sent to all the members and fellows entitled to vote.

BY-LAWS.

CHAPTER I.—*Of Members and Fellows.*

1. No person shall be considered an active member until he shall have signed the Constitution and paid his initiation fee; and unless the candidate shall comply with these conditions within three months from the date of his election, such election shall be void. No member in arrears shall be eligible as a fellow.

2. A resident member or fellow removing permanently from the city, may, on giving notice thereof, and on payment of his arrears, become a corresponding member; and a corresponding member who removes to the city, with the intention of making it his permanent residence, shall cease to be a corresponding member, but may become an active member on complying within six months with the provisions of the first section of this chapter.

3. Persons over 16 years of age may be elected members; but members under 21 years of age shall not be entitled to vote or hold office in the Academy.

CHAPTER II.—*Of Patrons and Life Members.*

1. Any person who shall have rendered illustrious services to the Academy or contributed at one time five hundred dollars, may, upon the recommendation of the Council and a three-fourths vote of the Academy, be elected a PATRON, with all the privileges of membership except voting and holding office.

2. Any member or fellow may become a LIFE MEMBER by contributing at one time one hundred dollars toward the permanent fund of the Society, and shall thereafter be exempt from annual dues and assessments.

CHAPTER III.—*Of Officers.*

1. The President, or in his absence, one of the Vice-Presidents, or in their absence, a Chairman *pro tempore,* shall preside at all meetings of the Academy, and shall have a casting vote. He shall preserve order, and shall decide all parliamentary questions, subject to an appeal to the Society. He shall appoint all committees authorized by the Academy, unless otherwise specially ordered.

2. The Secretary shall be present at all meetings of the Academy, and keep a record of the proceedings thereof. He shall take charge of all papers and documents belonging to the Society; shall keep a correct list of members and fellows; shall notify all resident members and fellows of their election, and committees of their appointment; and shall give notice to the Treasurer and to the Council of all matters requiring their action.

3. The Corresponding Secretary shall be charged with the correspondence of the Academy. It shall be his duty to be present at all meetings, to read all communications made to him in his official capacity; to keep a book in which shall be recorded the correspondence of the Academy, and the names of all corresponding and honorary members; to lay the same on the table at all regular meetings thereof; to notify corresponding and honorary members of their election; and to report to the Academy, at the annual meeting, the state of its correspondence.

4. The Treasurer shall have charge of all moneys belonging to the Academy, and, under its orders, of their investment, and shall give good and satisfactory security to the Society for the faithful discharge of the trust. He shall collect initiation fees, annual dues and assessments from all members and fellows, all subscriptions made in behalf of

the Academy, and any incomes that may accrue from the property belonging to the institution; shall report at the business meeting in January the names of members in arrears; shall give due notice to the Society of the expiration of all policies of insurance that may be effected on its property; and pay all debts against the Society which shall have been audited by the Committee of Finance, or the discharge of which shall have been ordered by the Academy at a regular business meeting. He shall furnish the Committee of Finance, on due application, with such information of the state of the funds as they may require; and shall report to the Academy, at each business meeting, the condition of its finances, and, at the annual meeting, the receipts and expenditures of the entire year.

5. The Librarian shall have the immediate supervision of the Library, under the authority of the Library committee. All accessions to the Library shall pass through his hands and he shall enter the titles to the same in a suitable book kept for that purpose. He shall indelibly stamp every book, pamphlet, paper or other matters, with the stamp of the Society, as prescribed by the Library committee or Council. He shall periodically make a detailed report of accessions, and, at the annual meeting, shall make a report on the condition of the library.

CHAPTER IV.—*Of the Council.*

1. The President, Vice-Presidents and Secretary of the Academy, shall hold the same offices in the Council. In the absence of any of them, officers *pro tempore* may be elected.

2. The Council shall meet at least once a month, within ten days preceding the regular meeting of the Academy. Minutes shall be kept of its proceedings, which may be called for at any business meeting, upon a vote of the Academy. Matters of a strictly personal nature, however, need not be entered on the minutes of the Council.

3. Five members of the Council, a majority of whom shall be fellows, shall constitute a quorum; but the Council may appoint an Executive Committee, or business may be transacted at a regular called meeting of the Council at which less than a quorum is present, subject to the written approval of a majority of the Council, subsequently given to the Secretary, and recorded by him with the minutes.

4. The Council shall prepare all business referred to it by the Academy, and may present any other business at its discretion. It shall frame its own rules and regulations, and determine the time and place of its meetings.

5. The Council shall organize within itself a Committee on Nominations, a Committee on Publications, a Committee on the Library, and a Committee on Finance, to whom, in the intervals of the meeting of the Council, all matters pertaining to these several subjects shall be referred. Their action shall always be subject to the revision of the Council. The names of the persons composing these Committees shall be kept publicly posted in the rooms of the Academy.

6. All business prepared by the Council shall be presented to the Academy by the Secretary, or, in his absence, by some other officer of the Council. But the Council may decline to present business at any meeting at which a majority of those present shall not be fellows.

CHAPTER V.—*Of Curators.*

1. The Council shall appoint five Curators, subject to confirmation by the Academy, who shall be the custodians of the collections and apparatus of the Society.

2. The Curators shall be separately charged with the safe keeping and arrangement of the several collections, and with the keys of the cabinets. Each Curator shall have his

particular department allotted to him when appointed. All regulations made by the Curators shall be approved by the Council before such regulations shall come into operation.

3. The Curator having charge of any division of the collection shall alone be authorized to select duplicate specimens from such division for the purpose of exchange or donation; but no exchange or donation shall be made except such as is authorized by a vote of the Council.

4. The increase and improvement of the collections being the inducement to exchange, it shall be the duty of the Curators to report to the Council all such opportunities to exchange as would favor this object.

Chapter VI.—*Of Committees.*

1. The Committee of Finance shall audit all accounts against the Academy, and shall have the duties and powers of a committee of Ways and Means. They shall report on financial questions referred to them, whenever called upon to do so by the Academy or the Council.

2. Committees for special purposes may be appointed when required.

Chapter VII.—*Of Sections.*

1. Sections of special branches of science may be established upon the written petition of ten members, five of whom shall be fellows. The request must be approved by the Council and ratified at a business meeting. But if the petitioners fail to organize such Section within six months of said approval all action relative to said Section shall be void. If an established Section shall fail to hold a meeting or to report to the Academy its proceedings during any period of twelve months, it shall be the duty of the Secretary to inform the Academy that it is extinct.

2. Sections shall be organized with at least a Chairman and Recorder.

3. Sections may increase the number of their members by election, but only members and fellows of the Academy may be elected to membership in the Sections.

4. The Academy will not be responsible for debts contracted by any Section, or by any officer or member thereof, without the approval of the Council.

5. All meetings of the Sections which are not private or working meetings, shall be held under the auspices and authority of the Academy; but the officers of a Section may take charge of the meeting of the Academy during the presentation of the scientific business of the Section.

6. Papers read in Academy meeting by any Section shall be credited, in the Proceedings, to that Section.

7. Each Section shall submit to the Academy at the Annual Meeting a report of its proceedings and work for the year.

8. The books and scientific material of all the Sections shall be the common property of the Academy, except in cases provided for by special agreement.

9. Donations to any Section shall be received as donations to the Academy for the use of that Section.

Chapter VIII.—*Of the Museum and Collections.*

1. All donations shall have the name of the donors affixed thereto.

2. All members shall have access to the Museum, subject to the regulations of the Academy.

3. All deposited specimens shall be labeled with the name of the depositor, and while they remain as such, shall be exclusively under the control of the Academy, and subject to the same uses and regulations as the specimens belonging to it.

4. No person making a deposit of specimens shall be allowed to remove them without giving a receipt for the same to the Curator in charge.

5. No specimen contained in the Museum shall be loaned, unless by special permission of the Academy.

6. The Curators shall arrange in systematic order all the specimens belonging to the Museum, and keep a catalogue of the same; and shall report to the Academy at the Annnal Meeting the state of the property confided to their charge.

CHAPTER IX.—*Of the Library.*

1. The Library shall be under the control of the Librarian and Library Committee.

2. No book shall be purchased, or other expenses incurred for the Library, except by a recommendation to that effect signed by a majority of the Library Committee, and ratified by the Council.

3. The Library Committee shall designate such books as ought not to be removed from the rooms of the Academy, and these books shall be marked on the catalogue, and shall not be taken out without special permission from the Academy.

4. The Librarian shall be furnished with a book, in which he shall keep a regular account of all books borrowed and returned, by inserting the name of the borrower and the book borrowed, and the time when taken out and when returned. In the absence of the Librarian, one of the Library Committee shall keep this record.

5. A member not returning a volume within two weeks, shall incur a fine of fifty cents, and twenty-five cents for each week thereafter.

6. Any injury done to works shall be estimated by the committee, and the borrower fined accordingly.

7. The Librarian shall report to the Treasurer, from time to time, the fines imposed.

8. No member or fellow shall take out more than two volumes at one time, without special permission from the Council.

9. On the first Monday in June, all books shall be called in; and the Library Committee shall examine the Library, and compare it with the catalogue. They shall note all missing books, and report the same, at the next meeting, to the Academy.

CHAPTER X.—*Of Meetings.*

1. The Stated Meetings shall be held on the second and fourth Monday evenings in each month.

2. Special Meetings may be called at any time, by the President, and shall be called, if requested in writing, by ten members or fellows.

3. Special Meetings shall be called by a notice sent to every active member or fellow, stating the time at which such meeting is to be held, and the object for which it is called, and no business shall be transacted except that stated in the call.

4. Stated Meetings shall be held in such place as shall be determined by the Academy or Council. When meetings are not held in the rooms of the Academy it shall be the duty of the Recording Secretary to notify all the fellows and members of the time and place of meeting. All business meetings shall be held in the rooms of the Academy.

5. Visitors at the meetings shall be introduced by one or more members, and their names shall be announced by the President, and entered on the minutes.

CHAPTER XI.—*Of Publication.*

1. The publications of the Academy shall consist of the Proceedings, and such other documents as shall be ordered by the Academy.

2. The publications shall be issued under the supervision of the Committee of Publication, and shall be furnished to members, fellows and subscribers at such rates as may be determined by the Academy. Complimentary copies may be sent to learned societies, educational institutions and public libraries, on the approval of the Council.

3. No member or fellow shall publish any part of the proceedings of the Academy, or any paper read before it, without the consent of the Council, or by a resolution of the Academy. Written communications which shall not be accepted for publication, or published within a reasonable time, shall be returned to their authors when requested.

CHAPTER XII.—*Of the Publication Fund.*

1. Contributions may be received towards establishing a Publication Fund; all such contributions shall be invested in United States or in New York State securities, and the income thereof be applied toward defraying the expense of the scientific publications of the Academy.

2. Contributors to this fund in the sum of fifty dollars, or more, at one time, shall be entitled to one copy of all the scientific publications of the Academy appearing subsequently to the date of the payment of their contribution.

CHAPTER XIII.—*Of Initiation Fees, Annual Dues, &c.*

1. At the time of admission every active member, excepting women, shall pay into the treasury, as an initiation fee, the sum of five dollars. Women shall pay only two dollars.

2. The annual dues of every male member or fellow shall be five dollars, and of women, two dollars, payable in the month of January.

3. Members may compound their dues at any time by the payment of one hundred dollars, and become LIFE MEMBERS, thereby becoming exempt from all further charges or assessments.

4. Corresponding and Honorary Members shall be exempt from fees, dues and assessments.

5. The Academy may exempt any member or fellow from his annual dues, provided the proposal be made at a regular business meeting, be approved by the Council, lie over until the next regular business meeting, and all the members then present agree thereto.

6. If any active member or fellow, in arrears for annual dues or assessments for over one year, shall neglect or refuse to liquidate the same within three months after notification by the Treasurer, his name may be erased from the rolls by vote of the Council.

7. All contributions received under the provisions of Sections 1 and 3 of this chapter, as also those received from the Patrons, shall be invested in United States or in New York State securities, and the income derived therefrom be applied to the general purposes of the Academy.

8. Assessments may be levied upon the active members and fellows, bnt only upon the recommendation of the Council, read at a regular business meeting, and a two-thirds vote of the fellows and members present at a succeeding regular business meeting. Assessments shall not exceed five dollars per member during any one year, and women shall be assessed only two-fifths the amount levied on men.

CHAPTER XIV.—*Of Business.*

1. All business other than such as relates immediately to the cultivation of science, shall be transacted only at the first meeting of the month,—except when the Council shall report it as urgent, in which case it may be transacted at any meeting, provided at least a week's notice shall have been given to all members and fellows.

2. The following shall be the regular order of business at the Stated Meetings:—

1. Reading of minutes of the preceding meeting.
2. Names of visitors announced.
3. Signing of the Constitution by new members.
4. Announcement of additions to the Library or Cabinets.
5. Examination of material exhibited.
6. Nominations for membership.
7. Reports of Council, Officers, and Committees (of a business character only at business meetings).
8. Deferred business. } Only at business meetings.
9. New business. } Only at business meetings.
10. Election of members. } Only at business meetings.
11. Election of officers. } Only at business meetings.
12. Presentation and discussion of announced papers.
13. Other scientific business.
14. Rough minutes read.
15. Adjournment.

CHAPTER XV.—*Of Nominations and Elections.*

1. The Annual Elections shall be conducted as follows:—

Nominations may be sent in writing to the Secretary, with the names of the proposers, at any time not less than thirty days before the Annual Meeting; and the Council shall prepare a list which shall constitute the regular ticket. This list shall be furnished to every active member and fellow at least two weeks before the Annual Election, and be publicly posted during that time in the rooms of the Academy. But any resident member or fellow shall be at liberty to alter this list, or to prepare another, and nominations may be made in open meeting at the time of the election.

2. The ballots shall be received and examined by at least two tellers, appointed by the presiding officer at the Annual Meeting. A list of the persons who have received the greatest number of votes of those present, certified by the tellers, shall then be presented by them to the presiding officer, who shall thereupon declare the said persons elected to their several offices, and shall present the list to the Secretary, who shall enter it on the minutes and file it; the ballots shall be destroyed as soon as a certified list is handed to the presiding officer. Officers shall hold over until their successors are elected.

3. Elections for members and fellows shall be held only on the first meeting of each month. Resident members shall be elected as follows: the candidates shall be proposed publicly in writing at any meeting, by a fellow or member; and the nominations, together with the name of the person making them, shall be referred to the Council; the report of the Council shall be openly read at the next regular business meeting, upon which the Academy shall proceed to a ballot. Names of candidates for corresponding or honorary membership shall be presented by the Council. The affirmative votes of three-fourths of those voting shall be necessary to elect a candidate.

4. Fellows shall be elected as follows: candidates shall be recommended to the Council in writing, with the reasons for such recommendation, signed by the proposer; then if the Council see fit, it shall publicly nominate them at a regular business meeting, and the names of such nominees shall be entered on the minutes, and then be posted in some conspicuous place during all meetings held in the rooms of the Academy, at least until the next regular business meeting. They shall be balloted for in the same manner as resident members.

CHAPTER XVI.—*Of General Provisions.*

1. No expenditure shall be incurred in behalf of the Academy, or disbursements made of greater amount than twenty-five dollars, unless authorized by a vote of a majority of the members and fellows present at a business meeting.

2. Any member or fellow may be censured, suspended or expelled from membership for violation of the Constitution or By-Laws, or for any other offense, by a vote of three-fourths of the members and fellows present at a business meeting, provided that such discipline shall have been recommended by the Council at a regular business meeting, and one month's notice of such recommendation and of the offense charged shall have been given the member accused.

3. No alteration shall be made in these By-Laws, unless such alteration be submitted publicly in writing, at a regular business meeting, be entered on the minutes with the name of the member or fellow proposing the same, and be adopted by two-thirds vote of the members and fellows present at a subsequent business meeting, notice of the proposed change having been sent to every member and fellow.

4. These By-Laws shall never be suspended except by unanimous vote.

The committee's report was accepted, and after discussion the revised Constitution and By-Laws submitted by the committee were provisionally adopted.

MARCH 11, 1889.

STATED MEETING.

Owing to the small attendance, the Academy adjourned to meet at the call of the President.

MARCH 24, 1889.

ADJOURNED MEETING.

No quorum being present the Academy adjourned to meet at the call of the President.

APRIL 19, 1889.

ADJOURNED MEETING.

Called by order of the President for final action upon the revision of the rules, and for election of officers.

In the Academy Hall, Reynold's Arcade.

The President, Supt. S. A. ELLIS, in the chair.

Prof. H. L. FAIRCHILD, of the University of Rochester, delivered a lecture, illustrated by lantern views, on

PREHISTORIC MAN.

On motion of J. E. Whitney, a vote of thanks was extended to the lecturer.

On motion of J. E. Whitney, the revised rules, as provisionally adopted February 25, were fully adopted by unanimous vote.

The election of officers was declared in order, under the amended rules, and resulted as follows :—

President, H. L. FAIRCHILD.
First Vice-President, J. EDW. LINE.
Second Vice-President, A. S. MANN.
Secretary, A. L. AREY.
Corresponding Secretary, S. A. ELLIS.
Treasurer, E. OCUMPAUGH, JR.
Librarian, MARY E. MACAULEY.

The election of Councillors was deferred until the next stated business meeting.

After discussion of ways and means the President was appointed a special committee to confer with the Trustees of the University of Rochester in reference to holding the meetings of the Academy at the University.

APRIL 29, 1889.

SPECIAL MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Twenty-nine persons present.

MR. EMIL KUICHLING read a paper

ON THE DISPOSAL OF THE EAST SIDE SEWAGE.

The paper was discussed by several members and visitors.

On motion of Maj. William Streeter Mr. Kuichling was given a vote of thanks.

MAY 13, 1889.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Twenty-six persons present.

A report was received from the Council which made the following recommendations:

(1.) The appointment of a special committee to confer with the Trustees of the University of Rochester concerning rooms in Anderson Hall for the use of the Sections of the Academy.

(2.) The appointment of a special committee to effect a settlement with the Trustees of the Reynolds Library for the expense of heating and lighting the rooms occupied for some years by the Academy, and to dispose of the chairs and unnecessary furniture.

(3.) The payment to J. E. Durand of a bill of $60.00 for part rental of a room used by the microscopical section.

(4.) The election as active members of the following persons:—

E. E. HOWELL,
EMIL KUICHLING,
J. Y. MCCLINTOCK,
H. L. PRESTON.

(5.) The election as fellows of the following members:

MYRON ADAMS,
CHAS. E. ALLING,
JAS. W. ALLIS,
H. F. ATWOOD,
EDWARD BAUSCH,
ROBERT BUNKER,
ADELBERT CRONISE,
SHELLY G. CRUMP,
S. A. ELLIS,
H. L. FAIRCHILD,
C. B. GARDNER,
H. ROY GILBERT,
GEORGE A. HARRIS,
S. A. LATTIMORE,
J. EDW. LINE,
S. A. LOWE,

A. S. Mann,
Mary E. Macauley,
Henry C. Maine,
M. L. Mallory,
Wm. M. Rebasz,
Geo. W. Rafter,
J. O. Roë,
Wm. Streeter,
J. Nelson Tubbs,
Z. F. Westervelt,
John Walton,
Jas. E. Whitney.

The Council report was accepted, and its several recommendations adopted with action as follows:

It was voted that the Committee under the first recommendation of the Council should consist of the President and Dr. M. L. Mallory.

It was voted that the Committee under the second recommendation should be appointed by the President with power to act. The President appointed as such committee, Prof. S. A. Ellis, Dr. M. L. Mallory and Maj. William Streeter.

The nominees for active membership were elected by formal ballot, and the bill ordered paid. The nominations for fellowship were laid on the table for one month, under the rules.

The election of six Councellors was ordered, and upon nomination the following were elected by formal ballot.

For a term of one year—

Edward Bausch,
S. A. Lattimore.

For a term of two years—

Florence Beckwith,
Jas. E. Whitney.

For a term of three years—

M. L. Mallory,
William Streeter.

The President reported that in reply to a formal request the Executive Committee of the University had granted the Academy permission to hold its meetings in the buildings of the University. And it was voted that when the Academy adjourned it should be to such time and place as should be determined by the President.

Prof. A. L. Arey read a paper, with experimental illustrations, on

SYMPATHETIC VIBRATIONS.

JUNE 10, 1889.

STATED MEETING.

In Anderson Hall, University of Rochester.

The President, PROF. H. L. FAIRCHILD, in the chair.

Forty-six persons present.

The council report recommended the payment of a bill for Secretary's expenses, and the election of JAMES G. GREEN as resident member. The bill was ordered paid, and the candidate elected.

DR. MALLORY, representing the special committee appointed to confer with the University Trustees regarding Section rooms, reported that rooms would be assigned.

MR. ELLIS reported, in behalf of the special committee on furniture and room expenses, that a settlement had been made with the Reynold's Library Trustees by transferring to them the chairs and furniture in the former Academy room.

The candidates for Fellowship nominated by the Council at the previous business meeting were elected by formal ballot, and by unanimous vote the Secretary was instructed to add his own name to the list, the rules being suspended by unanimous consent.

It was voted that a special committee should be appointed to prepare suitable resolutions expressing to the Trustees of the Reynold's Library the gratitude of the Academy for the many favors extended the society.

DR. LEWIS SWIFT read a paper on

THE SOLAR ECLIPSE OF JANUARY, 1889.

The thanks of the Academy were voted to Dr. Swift.

MR. WILLIAM STREETER directed attention to an excellent illustration of the rapidity of multiplication of certain microscopic plants. In the excavation for the Y. M. C. A. building, sixteen feet deep and now without drainage, the recent rains caused several inches depth of water. Upon the surface of this water a vegetable growth appeared, and within twenty-four hours spread over the whole surface. He had not yet been able to identify the species.

The PRESIDENT read a short passage from an article by John Sherman, in a small work entitled, "Beauties of Trenton Falls," by N. P. Willis, dated 1857, in which he propounded the theory that since the

Favosites, found at the falls, so much resembled in form the Basalt columns of Giants' Causeway, it was probable that these columns were a huge form of *Favosites*.

MR. H. K. PHINNEY described the formation of a columnar structure, analogous to that of trap dykes, in a block of sandstone which had been intensely heated in a coal fire.

PROF. S. A. LATTIMORE related how the Microscopical Society, from which the Academy sprung, had its beginning in an informal meeting in the very room in which the Academy was now meeting, which room was at that time his chemical lecture room. Personally and in behalf of the Corporation and Faculty of the University he welcomed the Society to the University, and hoped it had now ceased its migrations and found its permanent and appropriate home.

JUNE 24, 1889.

STATED MEETING.

In the Geological Lecture Room, Sibley Hall, University of Rochester.

The President, PROF. H. L. FAIRCHILD, in the chair.

Sixty-five persons present.

MR. H. L. PRESTON exhibited specimens of Topaz of unusual size, recently found in Japan.

MR. HENRY C. MAINE read a paper, illustrated by lantern views, on

SOLAR PHYSICS.

The subject was discussed by Prof. Lattimore, Mr. E. E. Howell, and the President.

MR. E. E. HOWELL exhibited a new iron meteorite from Erath Co., Texas, weighing 179 pounds, also a number of other meteoric specimens, and discussed the subject of meteors in general.

MR. WILLIAM STREETER called attention to a parasite found on the potato beetle when the latter feeds upon the tomato plant.

Adjourned to the second Monday in October.

OCTOBER 14, 1889.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Fifty persons present.

The Council report recommended,

(1.) The payment of certain bills.

(2.) The election as active members of the following candidates:

MR. SHERMAN CLARK,
MR. J. M. DAVISON,
MISS MARY A. DOOLITTLE,
MRS. F. A. HOPKINS,
MISS EDITH R. HOPKINS,
PROF. LOUIS H. MILLER,
MR. FRANK A. WARD.

(3.) That as early as practicable the Academy should begin the publication of its proceedings.

The items of the report were separately adopted, the bills ordered paid, and the candidates elected by formal ballot.

MR. J. E. PUTNAM read an illustrated paper on

RECENT ADVANCES IN TELEPHONY.

A circular letter was read from Mr. Robert H. Lamborn, offering prizes for the best three essays based on original experiments and observations bearing upon the destruction of mosquitos and flies by other insects.

OCTOBER 28, 1889.

STATED MEETING.

Held in the chapel of Anderson Hall, University of Rochester.

The President, PROF. H. L. FAIRCHILD, in the chair.

One hundred and twenty persons present.

A lecture was given by the PRESIDENT upon

THE GEYSERS AND HOT SPRINGS OF THE YELLOWSTONE NATIONAL PARK,

(Illustrated with lantern views.)

It was announced that following adjournment a meeting would be held for the organization of a Section of Geology.

NOVEMBER 11, 1889.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Thirty-two persons present.

The Council report recommended,

(1.) The payment of certain bills.

(2.) The election as resident members of the following candidates:

PRES. DAVID J. HILL,
REV. GEO. C. JONES,
DR. FRANZ MUECKE.

The bills were ordered paid and the candidates were elected by formal ballot.

MR. E. E. HOWELL exhibited a section, eight by twelve inches, cut from the meteorite which he had shown the Academy June 24th.

DR. M. A. VEEDER read an illustrated paper on

THE AURORA.

(*Abstract.*)*

Encircling each magnetic pole of the earth, there is, at a varying distance, a belt within which auroral display attains its maximum. During years when the solar photosphere is much rifted and torn, as though by eruptive forces, this belt extends to lower latitudes, and auroras are more widely seen. At such times the range of movement of the suspended magnet increases, and telegraph lines are more frequently disturbed by earth currents. Thus auroras, magnetic storms, and sun spots vary in frequency in like ratio to each other. This has become known, however, by systematic averaging through extended periods, and not by direct observation of individual coincidences. Nothing is more common than to find dark spots numerous upon the sun, but unattended by any appearance of the aurora, or perturbations of the mag-

*NOTE BY THE AUTHOR.—Aside from a few preliminary statements intended to summarize points that are contained in all ordinary text-books on the subject, the paper, of which this is an abstract, was based upon a systematic daily record kept by the writer. Each day a sketch and description of the condition of the sun has been recorded, and on the same page notes and references have been made in regard to all phenomena that were coincident, whose relation to each other and to the varying condition of the sun it has seemed desirable to investigate. The sources of the data thus brought together were in general as follows: The Monthly Weather Review issued by The Signal Service, The Signal Service Daily Weather Maps and International Daily Charts, Tracings from the Declination Magnetographs at the Naval Observatory, Washington, and at the observatories at Toronto and Los Angelos, telegraphic news items from the daily papers, articles in Nature, The American Meteorological Magazine, Science, etc. The behavior of the aurora in high latitudes has been studied, and notes have been made as above described, from the Report of the International Polar Expedition at Point Barrow. The aim has been to outline a method of research in accordance with which data may be systematically arranged, and each statement verified by any one who has the facilities and will employ them in the manner indicated.

Certain phases of this subject were presented by the writer at the New York and Toronto meetings of the American Association, and brief articles on the aurora have been furnished to Nature, to The Sidereal Messenger, to the Hydrographic Office, and to various newspapers, but the first formal presentation of the entire subject, embodying the conclusions stated in this synopsis, was in this paper before the Rochester Academy of Science.

netic needle. Fine auroras also have been seen during the entire absence of such spots. These exceptional cases are sufficiently numerous to prove that all sun spots, or, according to another view, sun spots in all locations upon the earthward side of the sun, are not capable of originating auroras. The occurrence of auroras in the absence of sun spots shows that there may be something else, increasing and diminishing in like ratio, that is concerned in their production. Very little systematic observation is required in order to make it plain that the outbreaks of glowing vapors known as the faculæ have an even more direct relation than the spots to the occurrence of the aurora. These vapors have been seen to be projected upwards at points on the sun's limb with velocities as extraordinary as two hundred miles per second. The dark spots on the other hand are simply depressions resembling whirlpools that form in the vicinity of such outbreaks. Photographs have been made showing the notch formed by a dark spot upon the sun's edge. From this it is evident that the eruptive forces find their direct expression in the formation of the faculæ, sun spots being a minor and subordinate result. Indeed disturbed areas have been seen to persist through successive revolutions for months together without the formation of dark spots, each return of the glowing points of faculæ being attended by auroras and magnetic perturbations. Thus it becomes evident in what way auroras may occur in the absence of dark spots, although auroras, sun spots and faculæ maintain a very similar ratio to each other, sun spots being more numerous when the sun is much disturbed, although not the most direct and positive evidence of solar activity.

This explanation of the occurrence of auroras in the absence of dark spots increases the difficulty however at another point. Although the sun is often free from spots it is scarcely ever free from groups of faculæ making the transit across its earthward side. Two such groups at an interval upon the sun's surface of thirteen days from each other would be sufficient to insure that one or the other should always be directed towards the earth, the one appearing at the eastern limb as the other disappears, by solar rotation, at the western limb. Accordingly it might be supposed that under such circumstances, auroras ought to continue all the time, or if there were but a single disturbed area that some evidence of its power to produce magnetic phenomena ought to be apparent more or less, throughout its entire transit, or during thirteen days at least at each return. As a matter of fact, however, auroras are comparatively short lived, even in the higher latitudes, and within the bounds of the United States are rarely seen at a single station for more than one or two nights in succession, no matter how brilliant the display may have been. From different stations they are usually reported for about four days in connection with a single well defined outbreak upon the sun. Longer continuance indicates a succession of solar outbreaks or the existence of a very extended area of disturbance. But even when disturbed areas are numerous, two, three or even more areas being visible, and these of large extent, it sometimes happens that no aurora whatever is reported and the magnets remain quiet for days together, tracing nearly straight lines without break or jog on the sensitized paper. This enigmatical behavior would be well nigh inexplicable or might perhaps be referred to some unknown peculiarity of the explosive forces at work, were it not for the fact of periodicity, corresponding to the time of the rotation of the sun. Numerous instances have been noted in which auroras of very exceptional brilliancy and extent have recurred many times in succession at intervals of precisely twenty-seven days. A very simple system of tabulation shows that this periodicity is a distinguishing characteristic of auroras in general. It is positive proof that the revolution of the sun on his axis is in some way involved. This being the case it is necessary to take into the account both solar rotation and disturbed areas, and to inquire at what point in their transit across the sun's surface these areas acquire the power of originating auroras. It is a noteworthy fact in this connection that auroras and magnetic storms are as a rule characterized by great abruptness of beginning. The excursions of the magnetic needle become very large almost instantaneously and require several days to die out gradually. In like manner auroral displays of the first magnitude burst forth without premonition, reaching their height at once and decreasing gradually, being less brilliant and reported from fewer stations on subsequent days. This behavior shows very clearly that it is not when solar disturbances are approaching the meridian that they produce auroras, in which case there would certainly be a gradual increase instead of such abruptness of beginning. Nor is this abruptness due, as might be supposed, to sudden variations in the explosive forces. It is in connection with precisely these grander outbreaks that there is the most exact periodicity and regularity of recurrence, a fact wholly inconsistent with the supposition that they are due to eruptive forces alone, such forces being necessarily irregular in their action. It is inconceivable that a magnetic storm, for example, due to these forces alone, should begin abruptly at the precise interval of six hundred and forty eight hours fourteen times, and should vary from this interval less than a few hours in several additional instances, all within the space of two years, as has been the case recently. The series of splendid auroras during the summer of 1886, and the magnificent double series during the winter of 1887–1888 exhibited an exact twenty-seven day periodicity entirely inconsistent with the idea that each outbreak was dependent upon a sudden developement of explosive energy alone. It is true that there are geysers in the Yellowstone Park and elsewhere that break forth with great regularity, but there can be no analogy to the case under consideration. Even if outbreaks upon the sun were geyser-like in their action, it would be necessary in order that this might become manifest in their earth-felt effects that their periodicity should invariably correspond closely to the time of the rotation of the sun, which is an altogether improbable assumption.

It is evident, however, that the abruptness of beginning and periodicity of magnetic storms and auroras is not inconsistent, to say the least, with the supposition that they owe their origin to disturbances appearing by rotation at the sun's eastern limb. Moreover the facts sustain this view. At times it has seemed as though outbreaks located elsewhere had been concerned, but by comparing the record during successive revolutions it has become apparent in many such cases that some small dot of faculæ at the eastern limb was really responsible; this mere dot at other returns developing into a disturbed area of vast extent, and being attended at each appearance for months by outbreaks of magnetic phenomena. Thus, judging the activity of disturbances by their history as well as their appearance, it has been found that there is a remarkable coincidence between the occurrence of auroras and the location of disturbances at the sun's eastern limb. In order to make this evident it is necessary to have access to records made by instruments which record magnetic perturbations automatically. It may be shown also by reference to reports of auroras from an area sufficiently large to overcome the influence of local conditions, which, for reasons not as yet understood, often prevent auroral display.

Employing the reports of the Signal Service Bureau it is found that during the three years from April 1886 to April 1889 there were one hundred and eighty-eight outbreaks of the aurora in the United States forming separate and well defined groups. In connection with one hundred and sixty-two of these observation of the sun was secured, and in every case a disturbance was found upon the sun's eastern edge, small it is true in some instances, but larger at other returns so as to be unmistakable. There were twenty-two other instances in which outbreaks appeared by rotation, no aurora being reported. It is possible however that it was visible in these cases at more northerly latitudes.

A curious feature noted when the auroras fail to appear, or are very faint, is an evident increase in the violence and extent of thunderstorms, as though they had taken the place of the auroras.

Tabulating observations of auroras so as to show their extent and distribution in periods of twenty-seven days, and tabulating in like manner magnetic perturbations so as to show their distribution in periods of six hundred and forty-eight hours, it becomes possible to determine at a glance the relative productiveness of different sections of the sun in relation to these phenomena. Such tabulation also affords a basis for comparisons in regard to manifestations of the forces concerned, other than the aurora. As has been indicated, it is possible that thunderstorms may be a reciprocal or alternative method of manifestation of forces, which under other conditions find their expression in the aurora. Systematic observation in regard to this point, upon a sufficiently extensive scale, may lead to results of the highest interest. At the time of the long series of earthquakes at Charleston and vicinity in 1886, there was manifest a periodic increase in the severity of the shocks, which seemed to indicate that magnetic induction from the sun might be concerned to some extent at least in the production of earthquake shocks in localities where the pre-existing conditions are thus favorable. The same peculiarity was noted in connection with the Riviera earthquake, and has led to much discussion among European scientists. Such comparisons as the writer has been able to make indicate that the conditions favorable to increase of auroras may be favorable also to increase of earthquakes, but other conditions as well must be taken into the account. For example, the violent earthquake shocks in the Mississippi Valley, coincident with the total destruction of Caraccas, South America, in 1811, occurred at a time when sun spots, auroras and magnetic storms were at a very decided minimum. Hence in this case magnetic induction, or the conditions originating it, could have played but little part.

There are certain facts in connection with meteorology that point to the influence of forces of cosmical origin and variable nature The International Daily Weather Charts show, for example, that at times the barometer fluctuates, within twenty-four hours, in precisely the same way, at all centers of high and low barometer, as though some impulse had been imparted to the entire atmosphere. In like manner extreme weather conditions of every sort have not unfrequently been observed to be of world wide extent. At the time of the "New York Blizzard" a series of phenomenal wind storms belted the entire earth. In 1877 and 1878, continents, islands and seas everywhere throughout the equatorial regions experienced unprecedented droughts. Southern France was without rain or snow for a whole winter. There were terrible famines in India and China due to drought. Egypt, Morocco and Cape Colony, Africa, likewise suffered greatly from the same cause. In Guiana, Venezuela, Colombia, Brazil and other parts of South America there was the same lack of rain, the drought at Ceara, Brazil, being the most disastrous on record. Even the Samoan Islands in the midst of the Pacific ocean were visited by a severe and altogether unusual drought. Australia and New Guinea likewise suffered, nor did the West Indias escape. In like manner there have been years noted for the wide prevalence of extreme cold, and other years in which phenomenal high temperatures were recorded at numerous points throughout both hemispheres. It would certainly seem not unreasonable that such well marked divergence from ordinary conditions should find their explanation in the varying condition of the sun. The construction of curves showing mean precipitation, cloudiness, temperature and barometric range, at a few selected stations, however, gives wholly inconclusive results as regards any relations which these conditions sustain toward each other, or toward the varying condition of the sun. Such curves for example have appeared to indicate that there is no connection between barometric range and precipitation, thus contradicting the results of the simplest observation. It is impossible by any such method to show whether there is any connection between the varying condition of the sun and meteorological phenomena, unless observation can be combined from practically the entire earth. In want of such fullness of information from a sufficiently wide area the only resource is to select extreme cases like those which have been noted, and study the coincident solar conditions, following the method which has been found to be applicable in the case of the aurora. Thus it may become possible to learn whether there are distinctive features, attending, for a longer or shorter time, particular disturbed areas upon the sun. The very complete identification of certain areas by their auroral and magnetic concomitants, opens the way for discriminating and intelligent study, very different from merely counting sun spots. It is too soon, as yet, to say what may be the result of such study. Enough has been learned however to indicate that the problem is worth attacking in this way. But without thus broadening the subject, much may be learned by the study of the aurora alone. The systematic investigation and tabulation of results along the lines that have been indicated cannot fail to throw light upon the physical constitution of the sun, and upon the nature of thermal, electrical and perhaps other forces of solar origin. This, like every other advance in knowledge, may be expected to yield practical results. At least we may hope to contribute somewhat toward dispelling the mystery of the aurora which has so long baffled the curiosity of mankind.

NOVEMBER 25, 1889.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Thirty-seven persons present.

MR. H. L. PRESTON exhibited so-called "mummy-eyes" found with Peruvian mummies. The President said they were undoubtedly the crystalline lenses from the eyes of the "cuttle-fish."

MR. J. E. PUTNAM showed and explained a Weston direct-reading voltmeter.

The Secretary, PROF. A. L. AREY, read a paper, with experimental illustrations, on

NEW METHODS OF PHYSICAL MEASUREMENT.

DECEMBER 9, 1889.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Thirty persons present.

The Council report recommended,

(1.) The payment of certain bills.

(2.) The election as active members of the following candidates:

SERGT. W. O. BAILEY,
MISS JEANNETTE BENNETT,
MRS. C. M. CURTIS,
MR. A. ERNISSE,
MISS KATE LEWIS,
MR. W. C. WORTHINGTON.

The bills were ordered paid and the candidates elected by formal ballot.

DR. E. V STODDARD read a paper on

THE ECONOMIC ASPECTS OF HYGIENE.

The thanks of the Academy were voted to Dr. Stoddard.

JANUARY 13, 1890.

ELEVENTH ANNUAL MEETING.

In Anderson Hall, University of Rochester.

The President, PROF. H. L. FAIRCHILD. in the chair.

Sixty persons present.

The Council report recommended the election as active members of the following candidates:

MR. GEO. J. MCLAUGHLIN,
MR. JOSEPH O'CONNOR,
MR. JOSEPH W. PRESSEY,
DR. E. V. STODDARD,
MRS. H. E. WELLS,

who were elected by formal ballot.

The Annual Reports of the officers and sections were presented.

SECRETARY'S REPORT.

The Report of the Secretary, PROF. A. L. AREY, stated that the reorganization of the Academy, effected April 19, 1889, had greatly increased the activity and efficiency of the Society. Stated meetings are now held twice each month, at the University of Rochester, the first meeting there being held June 10th. The number of meetings during the year is thirteen and the average attendance was fifty-one persons.

During the year twenty resignations have been accepted, and twenty-six new members have been received, showing an increase in total membership, notwithstanding the change of fees and dues from two dollars to five. The active membership is now one hundred and seventy-two.

Twenty-nine members have been elected fellows.

During the year ten papers have been read: one each in Engineering and Hygiene, two each in Astronomy and Geology, and four in Physics.

The REPORT OF THE TREASURER, E. OCUMPAUGH, JR., showed a surplus of ninety-six dollars in the treasury, and no outstanding indebtedness.

REPORT OF BOTANICAL SECTION

Read by MRS. J. H. McGUIRE, the Recorder of the Section:

The Botanical Section of the Academy of Science was organized April 13, 1881, at the house of Mr. Wm. Streeter, No. 14 Scio street, at a meeting called for that purpose, and the following officers were elected: Mr. Geo. T. Fish, *President;* Mrs. T. D. Spencer, *Vice-President;* Mrs. Mary E. Streeter, *Secretary.*

The aim of the Section was the systematic study of botany, and the collection and identification of the plants indigenous to Rochester and its vicinity, with the design of publishing a complete list of the flora of Monroe county. Suitable cabinets for the preservation of specimens were procured and a committee consisting of Messrs. C. M. Booth, H. C. Maine and C. W. Seelye was appointed to decide what specimens should be placed in the herbarium and to pronounce upon the correctness of nomenclature, Gray's botany being adopted as the standard. Additions to the herbarium have been made from time to time, until it now numbers over one thousand specimens. The largest contributions were made by Mr. E. L. Hankinson, of Wayne, and are especially valuable in having been mounted by him, ready for the herbarium. No difficulty is anticipated in completing the collection of the flora of Monroe county, as a botanist stands ready to supply whatever specimens may be lacking. A fine collection of Colorado plants gathered and prepared by Miss Mary E. Macauley, was presented by her to the Section, making a very valuable and interesting addition. Plants have also been received from California, Australia, the Feejee Islands, and New Zealand. These have been for the most part unmounted, and the work of mounting has been done by the Section. Those from Australia were sent to effect an exchange of American plants. The Section is now engaged in collecting specimens for this purpose, which, when the requisite number is obtained, will be forwarded to Australia.

Since its organization, nearly nine years ago, the Section has met regularly, with varying attendance as to numbers, but during that period there has been no suspension of meetings.

Papers on the more prominent orders of plants have been read by different members, before the Section, which has also received instruction from other botanists, among whom were Mr. C. W. Seelye, Prof. John G. Allen, and Prof. Lennon, of Brockport. Two fine pictures, a portrait of Prof. Asa Gray, and a group of Ophioglosseæ, representing this suborder complete for the United States, were presented by Mr. Seelye. They were handsomely framed as companion pictures, and testified to his unflagging interest in the work of the Section.

During the winter of 1885–6, a portion of the Section were engaged in the study of "Anatomy and Histology of Plants." They were supplied with caligraph copies of "Laboratory Directions," and on some occasions also with specimens from the botanical laboratory of Cornell University. These were sent at regular intervals, just as they were prepared for the class in that institution. This courtesy was entirely without remuneration and is very gratefully acknowledged. The Section is also indebted to Mr. W. H. Kislingbury for a collection of Polar plants mounted and framed, which, aside from its value as representing the flora of the Arctic regions, possesses a melancholy interest in having been gathered and prepared by his brother, the lamented Lieut. Kislingbury of the ill-fated Greely expedition.

At rare intervals plants have been found in this vicinity whose habitat is many miles from the place of discovery. One example is the *Nasturtium sylvestre*, which was found by Miss Sellinger near the Lower Falls; as it was never before known to grow so far West, the specimen was sent to Prof. Gray, by Mrs. Streeter, at that time President of the Botanical Section, who received from him a letter of acknowledgment.

The *Polygala polyganum* which has both aerial and underground blossoms was found near Penfield. The plant was a fine one, and was much admired by all who saw it. The tiny purple blossoms of the stem formed a striking contrast to the pendulous waxen flowers of the roots. An artistic member of the Section, who was also the fortunate discoverer of the plant, made a fine drawing of it for Mr. W. H. Kimball.

A remarkable specimen in teratology was furnished by Miss Beckwith. This was an abnormal rose, in which the stem was prolonged through the flower, and bore a number of leaves. The last petal was fully half an inch above the others, and like them was attached to the stem. An illustrated account of this abnormal growth was published in Vick's Magazine for September, 1889.

During the past year the work of the Section has been chiefly confined to the study of Algæ, and of vegetable histology, using Bessey's Botany for the text book. The practical studies therein designated have been as far as possible repeated in the class, and the exhibits with the microscope have not only equalled the illustrations, but in many instances have surpassed them.

The *Batrachospermum moniliforme*, an humble fresh water form of a higher group of marine algæ, and said to be the first discovery in this locality, was brought to the Section by Mr. A. M. Dumond. Its beauty and extreme delicacy render it worthy of its aristocratic relation. At the last meeting a curious growth of *Chara* was noted. This was the formation of extra whorls of leaves growing out of the leaves of the natural whorls. Perhaps the artificial condition under which it was grown may account for the phenomenon.

A remarkable collection of diatoms in the possession of Mr. Streeter, comprising nearly 800 slides, mounted by Prof. H. L. Smith, has been an unfailing source of pleasure and profit. Since the removal of the Academy from the Reynolds building, the Section has met at the residence of Mr. Streeter, where every facility for botanical and microscopical study is enjoyed. The Section is greatly indebted to him for these privileges, as well as for the use of his reference library and illustrated catalogues.

This very brief review of the work of the Botanical Section of the Academy of Science would be incomplete without grateful reference being made to Mrs. Mary E. Streeter, to whom the successful inauguration of the Section is largely due. For many years its President, she brought to the meetings an enthusiasm for her favorite science which was an inspiration to all who listened to her instruction. Her gracious presence encouraged the humblest student of botany, and her accurate knowledge and breadth of view, which kept her conversant with the advances made in the botanical world, were a tower of strength to the Section. By her death, which occurred in June, 1885, the Section sustained an irreparable loss. But the influence of her life and example still remains, and the memory of what she accomplished is a constant inspiration to botanical research.

REPORT OF GEOLOGICAL SECTION

(*in abstract,*)

Read by H. L. PRESTON, Recorder of the Section :

The Geological Section was reorganized October 28, 1889, with eleven persons present. The officers elected were, Chairman, E. E. Howell; Vice-chairman, A. L. Arey; Recorder, H. L. Preston. A Sectional Committee was elected December 2, subsequent to the adoption of rules, consisting of J. M. Davison and H. L. Fairchild. The chairman is *ex-officio* a member of this committee. The membership of the Section is now sixteen.

The meetings, six in all to this date, are held on the Tuesday evenings following the first and third Mondays of each month, in the geological lecture room, Sibley Hall, University of Rochester.

The rules under which the Section is working are intended to combine at each meeting the proper scientific work of the Section with some instruction in the science, in order to reach and benefit all classes of its membership. In pursuance of this plan a portion of LeConte's Elements of Geology has been assigned for discussion at each meeting, following the proper sectional work.

Extracts from the minutes of the Section.

October 28, 1889. The meeting was wholly devoted to organization.

November 4, 1889. The chairman, Mr. E. E. Howell, exhibited a section of the iron meteorite from Hamilton county, Texas, showed at the June meeting of Academy, and then supposed to be from Erath Co. The section measured nine by twelve inches, and the cutting required five hundred hours.

Miss Ada M. King exhibited a Hamilton coral, *Michelina.*

Mr. A. S. Mann exhibited a silicified mass of crinoid stems, from Greenwood county, Kansas.

The geological map of New York city and vicinity, prepared by Prof. D. S. Martin, was explained by Prof. Fairchild, and specimens of the New York rocks were exhibited.

Prof. A. L. Arey donated to the Section one hundred identified specimens of local fossils, on condition of a suitable place of deposit being provided.

November 18, 1889. The rules for the government of the Section were reported by committee and adopted.

Mr. J. M. Davison remarked upon a bezoar which had been exhibited, and discussed their formation.

A fragment of drift-boulder impregnated with garnets was exhibited by Prof. Fairchild. Dr. Muecke presented specimens of a red celestite found by him in the quarries at Brighton, and discussed their origin and occurrence.

Mr. Preston read the following notes on some minerals from Magnet Cove, Arkansas, and exhibited the specimens.

Messrs. Ward & Howell lately received from Magnet Cove, Arkansas, two shipments of mineralogical specimens, in which there were some species that have not before been positively credited to that locality, as far as I know, and others that have been quite rare. Among these was a specimen of yellow titanite which shows one or two crystals of small size of the typical form found so abundantly at Renfrew, Canada, but of a yellow instead of a brown color, and two or three small twin crystals having a form similar to those of the Tyrolese alps; I was quite sure from the physical character that this was titanite, and Mr. J. M. Davison has kindly proven their character by chemical test in the University Labratory. Although Magnetic Cove has long been noted for its various forms of oxides of titanium, this is the first instance to my knowledge that a silicate of titanium has been found at this locallty.

In the first box received there were several small and much weathered crystals of idocrase or vesuvianite, and in the second lot there were specimens of this mineral in crystals and fragmentary crystals measuring from 9 to 13½ centimeters in their greatest diameter, which are of unusual size for vesuvianite. Another interesting feature of these crystals is the fact that in most of them the prisms terminate in a pyramid or zirconoid, instead of terminating in the basal plane as is the usual case. All of these crystals were doubly terminated.

There were also a number of specimens of tremolite more or less associated with a gangue rock. Among the tremolite was one small crystal with a perfect termination of a delicate yellowish tint, almost transparent, which is rather unusual for tremolite, as distinct crystals are seldom found from any locality.

There were also a few specimens showing blotches of what at first sight seemed to be a red variety of tourmaline, but proved to be eudialyte. These blotches measured from 4 to 28 millimeters in diameter, and among them two specimens showing crystals measuring 9 and 10 millimeters in length, the latter showing both terminations of the crystal. These crystals were, however, of poor color.

There were numerous specimens of pyroxene in form like the fassaite crystals from the Fassa Valley, the first that I have seen, and also a few specimens showing small, slender crystals of the black variety of tourmaline.

The previously assigned topic for discussion, atmospheric agencies, was there taken up, during which discussion Mr. Howell exhibited specimens of marble from the Colorado cañon, showing the effect of erosion, one by the sand blast, the other by water.

Fossils and minerals from the Black Hills were presented by Mr. McNeal for identification.

December 2, 1889. The Sectional Committee were elected.

Two specimens of dolomite from the west side of the Genesee river, north of the rapids, were presented by Mr. Walker. An unusually large bezoar from a horse, six inches in diameter, was exhibited by Mr.

Crump, and a smaller one by Mr. Howell. Mr. Preston showed an artificial ruby.

Mr. Davison exhibited a specimen of granite from near Saratoga, which had been changed by the heat of adjacent trap eruption. The garnet was changed to chlorite, the orthoclase to kaolin, while the mica had become hydrous.

Dr. Muecke showed a specimen of the red celestite, similar to those exhibited at former meetings, but surrounded by clay and occupying a cavity in coarse sandstone. He also showed a specimen of Niagara limestone containing phosphate.

The topic for the evening, erosion, by rain and rivers, was illustrated by lantern views.

Specimens were presented for identification.

December 16, 1889. Mr. Davison showed a microscope slide which he had prepared from the red celestite brought in at a former meeting by Dr. Muecke. Under a magnification of 150 diameters, scales of hematite could be seen, measuring $\frac{1}{50}$ m. m. long and a width of $\frac{1}{700}$ m. m. to $\frac{1}{100}$ m. m. Under a higher power groups of small particles could be seen as points of red light. The red color of the mineral was believed by Mr. Davison to be due to the hematite.

The topic of the evening was waves and tides. Mr. Howell described the bar formed at San Diego, Cal., so large as to be laid out in building lots. Remarks were made by Mr. Crump and Mr. Howell upon the recession of Niagara Falls, and Dr. Muecke spoke of an interesting case of erosion at the canal lock at Brighton.

Several specimens were offered for identification.

January 5, 1890. Mr. Preston exhibited some chalcedonies, with fluid inclusions, found in basalt in Uruguay. Also several minerals from northern New York, among which was a fine crystal of altered titanite called xanthitane. He had obtained with the latter one specimen of titanite which had been changed to steatite, and some large rough crystals of titanite weighing from twenty-five to forty-five pounds. These were found in a vein of pyroxene, firmly wedged between huge crystals of the latter, some being a foot in diameter. A fluorite of a beautiful delicate green was shown, being one of a large lot found in a chamber in the rock at Macomb, St. Lawrence county. The pocket was eight feet below the surface, about fourteen feet long and from three to four feet high, the walls completely covered with groups of fluor crystals of various shades of green, some over a foot in diameter, and transparent.

The topic being the action of ice, Mr. Howell spoke of the possible causes of the glacial area being mostly east of the Rocky mountains. He also described a peculiar ridge around Fish lake, Utah. This was a glacial lake, 9000 feet above sea level and held by a glacial moraine. The ridge was formed by the expansion and contraction of the ice under changes of temperature; in expansion the ice pushed up the loose material until a "windrow" three to four feet high had been accumulated.

The Annual Election of Officers for the ensuing year was held which resulted as follows:

President, H. L. FAIRCHILD.
First Vice President, S. A. ELLIS.
Second Vice President, A. S. MANN.
Secretary, A. L. AREY.
Corresponding Secretary, GEO. W. RAFTER.
Treasurer, E. E. HOWELL.
Librarian, MARY E. MACAULEY.
Councillors, J. M. DAVISON, C. F. PAINE.

MRS. C. M. CURTIS read a paper, illustrated with lantern views, on

THE NEBULAR HYPOTHESIS.

JANUARY 27, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Forty-three persons present.

SERGT. W. O. BAILEY read a paper on

SIGNAL SERVICE METHODS OF PREDICTING WEATHER CHANGES.

The paper was discussed at length by Dr. M. A. Veeder and other members.

FEBRUARY 10, 1890.

STATED MEETING.

Held in the physical lecture room, Rochester Free Academy.

Vice-President S. A. ELLIS, in the chair.

Eighty-nine persons present.

The Council report recommended,

(1.) The organization of a Section of Zoology in response to the petition of members.

(2.) The payment of certain bills.

The report was adopted.

The paper of the evening was read by MR. CHARLES N. PRATT, on

PROGRESS IN INCANDESCENT ELECTRIC LIGHTING.

The paper was illustrated by experiments and drawings, and was discussed by many members. Following adjournment, the members, upon invitation, inspected the Edison Electric Light Station.

FEBRUARY 24, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Fifty-five persons present.

DR. J. L. ROSEBOOM read an illustrated paper upon

BACTERIA IN DISEASE.

The discussion following was participated in by Mr. E. Kuichling, Mr. Geo. W. Rafter, Supt. S. A. Ellis, Mr. L. C. McNeal, Mrs. C. M. Curtis and the President.

MARCH 10, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Fifty persons present.

The Council report recommended,

(1) The payment of certain bills.

(2.) The election of Hon. M. W. Cook and Prof. Henry A. Ward as active members.

(3.) The adoption of a resolution in substance authorizing the Corresponding Secretary to purchase books for the Academy, not to exceed in amount five hundred dollars, and to himself advance the money, holding the books as security.

The items of the report were adopted, and the nominees elected by formal ballot.

The following resolution offered by Supt. S. A. Ellis was adopted:

Resolved: That Mr. Henry C. Maine who has been connected with the Academy from its foundation, and who was for some time its Secretary, be requested to prepare a brief history of the Academy from its foundation to the time of the late reorganization.

The following paper was read:

BIOLOGICAL EXAMINATION OF POTABLE WATER,

By George W. Rafter.

The biological examination of water requires the determination of all the minute life occurring in various classes of water, and is divided into two distinct investigations, the microscopical and the bacterial. The microscopical examination includes the determination of all those forms of life which are easily studied in all their phases by use of the microscope. These forms include among plants, algæ, larger fungi, etc., and among animals, sponges, infusoria, rotifers, the smaller crustacea and others.

The bacterial examination requires cultures as an integral part of the process, and only incidentally makes use of the microscope, inasmuch as examinations and partial identifications may be made from plate and tube cultures without the use of the microscope at all.

The methods of making bacterial examinations have been fairly worked out for several years, but until recently no definite method of making the accurate determination of the number of the so-called microscopic forms has been known.

The present paper includes the microscopical examination only, and the methods here indicated have no reference to the bacteria.

Something over three years ago the Microscopical Section of this Academy began a systematic study of the forms of minute life present in the Hemlock lake water supply of this city. The method of obtaining specimens was to fasten a bag of plain muslin to a kitchen faucet and allow the water to flow through until the pores of the cloth were partially clogged with the arrested organisms; the bag was then removed from the faucet, turned wrong side out and the organisms washed off into a beaker or tumbler. Subsidence took place in a few minutes, after which specimens for examination were selected by dipping with a small tube or medicine dropper from different depths. This was the only method used during the two years that the Microscopical Section was engaged upon this special study, and indeed was as practical a method as any that had up to that time been devised.

McDonald, in his Water Analysis, had suggested several years before the use of a watch glass suspended in a tall glass of comparatively small diameter, for instance a 500 c. c. measure glass. His method of procedure was essentially to fill such a measure glass with the water to be examined, and to suspend in it at the bottom a watch glass, after which the whole, lightly covered, was set aside for perhaps 24 hours. At the end of this time the water was siphoned off with a piece of India rubber tubing so as to leave only a thin stratum of liquid in the watch glass at the bottom. The watch glass was now raised and samples selected with a pipette for examination on a glass slide, or the watch glass itself placed upon the stage of the microscope for direct examination. This method was, at the best, crude and unsatisfactory, and as it could give only qualitative results, it is doubtful if with any operator it has ever passed much beyond the experimental stage. The method used by the Microscopical Section was somewhat more simple, and gave all the information that could be obtained by the use of the more elaborate method of McDonald.

Mr. Hogg in the tenth edition of his work on the microscope has added a chapter on the microscopical examination of potable water, but without advancing any methods other than those previously announced by McDonald. Likewise *Tiemann and Gärtner*, the recent German authorities, have added nothing to our knowledge of this part of the subject.

The matter of qualitative examination of the micro-organisms in potable water remained in about the state indicated by the foregoing until a little less than a year ago, when Prof. Wm. T. Sedgwick, of the Massachusetts Institute of Technology, worked out a method for making the quantitative determination as well.* This consists, first, in the concentration of the organisms in a large amount of water into so little water that they may be readily examined under the conditions imposed by microscopical technique; and, second, of an

*See paper on Recent Progress in Biological Water Analysis in Transactions of New England Water Works Association September, 1889.

actual enumeration of all the organisms present in a given quantity of water. The first point is attained by filtration through a short column of fine sand in the lower end of the stem of a small funnel, the sand being supported upon some material which will allow the water to pass freely and still retain the sand in position. After placing the sand, a measured quantity of water is poured into the funnel and allowed to filter through. The sand retains nearly all the organisms which were originally distributed through the water. The enumeration is secured, according to Prof. Sedgwick, by removing the supporting plug and washing the sand and contained organisms into a cell, 50 x 20 millimetres in area, and about 2 to 2½ millimetres in depth. The glass bottom of this cell is ruled into square millimetres and by passing a number of these squares through the field of a microscope their contents are counted and from the counts so made the whole number present in the cell is obtained. This method while far in advance of that of McDonald

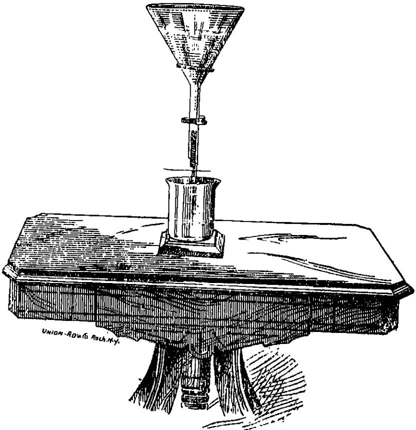

FIG. 0.—FUNNEL WITH PLUG AND SAND IN PLACE.

is still somewhat unsatisfactory in this, that the sand and organisms are both allowed to pass into the cell together, and inasmuch as the finest grains of sand are much larger than many of the organisms, it follows that the enumeration, however carefully made, is only a rough approximation to the number actually present, and usually falls short of the number actually present.

The method of Prof. Sedgwick came to my notice about nine months ago, and after examination it appeared quite evident that considerable additional refinement was possible, and to this I addressed myselt with the result of finally perfecting the technique in the manner which I now briefly lay before you.

In the method, as I now use it, the sand is supported upon a plug of wire cloth placed at the lower end of the funnel stem, as shown in figure o. After placing the plug the sand is run into the funnel, lightly pressed to place with a glass rod, and from 20 to 40 c. c. of freshly filtered water allowed to run through in order to insure thorough settling of the sand before actually beginning the filtration. The amount of water to be filtered is gauged by the number of organisms which it contains, as ascertained by preliminary inspection. Generally, however, as large a quantity should be used as can be conveniently filtered without clogging the sand so much as to render the completion of the process too prolonged, and for ordinary samples I have fixed upon 500 c. c. as the proper amount. In the case of very pure waters a larger amount will be desirable, and for such 1000 c. c. may be adopted as a convenient unit.

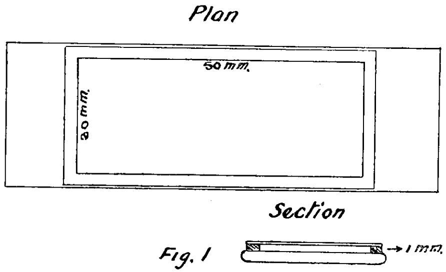

Fig. 1. Plan and Section of Cell with cover glass.

Experience indicates that however carefully the sand may be placed, the filtration at the beginning will not be as complete as further on, and in order to insure the certain removal of all the smaller organisms the first 100 to 150 c. c. of the filtrate is returned to the funnel and passed through the sand the second time. The funnel is allowed to stand until the completion of the filtration, when it is found on examination of the filtrate that nearly every organism has been removed and we have the result that the organisms originally contained in the 500 c. c. of water are all in the sand at lower end of funnel stem. The plug of wire cloth is now removed, and the sand and contained organisms washed with 5 c. c. of freshly filtered water, run from a 5 c. c. pipette, into a 5 or 6 inch test tube. The test tube is slightly shaken in order to wash all the organisms clear from the sand. The sand by reason of greater specific gravity sinks quickly to the bottom, leaving the organisms distributed through the water. At the instant of the completion of the settling of the sand the supernatant water is turned into another smaller test tube, leaving the clean sand at the bottom of the first tube. We now have the organisms from 500 c. c. of water concentrated into 5 c. c. in the second tube, from which after slight stirring, to insure uniform distribution, 1 c. c. is taken with a 1 c. c. pipette and transferred to a cell 50 by 20 millimetre area, and exactly 1 millimetre in depth. Such a cell of course contains 1000 cubic millimetres, or 1 c. c. The top of the metal cell is ground perfectly smooth and with a little practice one can float a thick cover glass to place without losing a drop.

The next step is the enumeration. This is accomplished by transferring the cell to the stage of a microscope, the eye-piece of which is fitted with a micrometer so ruled as to cover, with a given objective, and fixed tube length, a square millimetre on the stage. The microscope itself is fitted with a mechanical stage with millimetre movement in both directions; and for this purpose I have made certain simple additions to the new mechanical stage of the Bausch and Lomb Optical Company, by means of which the desired result is obtained at slight expense. The count is made by beginning at one corner of the cell and going systematically over the area in accordance with such a formula as will insure the count of squares selected from every part of the slide. The number of squares actually counted will depend upon the degree of accuracy which it is desired to attain. It is obviously impossible to count the 1000 squares composing the entire area of the slide, and the practical question arises as to just what multiple of 1000 shall be used to secure a correct average. This can only be determined by trial and comparison upon a number of samples. In any case not less than 20 squares should be counted, and if time will possibly permit I should prefer to always count at least 50.

In order to illustrate the matter, I have prepared a table which represents the area of the cell divided into 1000 squares. Brief inspection of this table will show the difficulty of obtaining true averages when only 20 squares are counted, and exhibits clearly the value of counting the larger number if one cares for true averages. (See Plate 1.)

Table No 1. Enlarged outline plan of counting cell 20 mm by 50 mm divided into squares each representing one square millimetre

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250
251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350
351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400
401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450
451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500
501	502	603	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550
551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650
651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750
751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800
801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850
851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900
901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950
951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000

I consider the precise millimetre movement of the mechanical stage a matter of considerable importance, and indeed insist upon it as an integral part of the method. Without it the tendency will be to sometimes select squares for counting which are contiguous, while at other times one will pass over squares containing few or no organisms in a search for more prolific ones, making, in either case, an error in the final result. By use of the mechanical stage with a definite formula for passing over the slide, personal errors of this sort are eliminated, leaving only those which are due to irregularity of distribution of the organisms in the water, and by always stirring thoroughly before taking the portion for examination with 1 c. c. pipette this error may also be reduced to a small degree, provided as many as 50 squares are counted as the basis of the final average. Additional uniformity of distribution of organisms in the cell may also be obtained by stirring gently in the cell itself with the pointed end of the pipette, before floating the cover glass to place, but the precaution should always be taken in these stirring operations to proceed gently in order to guard against breaking up unnecessarily the particles of amorphous organic matter which are nearly always present in any sample of water in which algous growths and decay are taking place.

Fig. 2

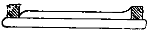

Fig. 2. Section of open cell showing curve of surface of fluid due to capillary attraction at sides.

The definite estimation of the amorphous organic matter is a thing of some difficulty, and in my own use of this method I have formed a sort of mental standard as to the unit of area covered by one mass of the amorphous matter. Mr. Geo. C. Whipple, who has assisted me in some experimental work for the Boston Water Works, has suggested that this unit be made definite for all persons by taking it a fixed number of square microns, and for this purpose 20 microns seems to be the desirable unit. By careful comparison with a stage micrometer for a few times this unit can be firmly fixed in mind and an estimate of the amount of amorphous matter made with considerable precision.

The advantage of a cell of such depth as to just contain the quantity taken for examination is illustrated by figure 2, which represents the *open* cell and shows the meniscus form taken by the liquid, by reason of capillary attraction at the sides. This curvature is so considerable as to render a count in the squares near the edges of the cell impracticable, for optical reasons, which every user of the microscope will readily understand. With the covered cell on the contrary the count may be made up to the sides as easily and with as much certainty as in the middle.

The placing of the cover glass is easily accomplished, although the careful observance of certain details are essential to uniform success. Thus the cover glass should be perfectly clean, and just before placing should be moistened. The operation of putting it to place consists in laying one end, held in a horizontal position, in contact with the ground upper surface of the metallic portion of the cell, and, while keeping it in close contact at all points, gradually sliding it forward until the whole cell is covered.

In this connection it may be noted that cleanliness is quite essential in all these operations, and the hints given by McDonald in his Water Analysis fully cover the case.

In the original cell, as designed by Prof. Sedgwick, the division into squares for the purpose of obtaining the relation of organisms to area was arrived at by ruling square millimetres upon the upper surface of the glass slide on which the cell is based. This, however, gives a unit square only for the bottom of the cell, and for all organisms at the top of the liquid no unit of area is obtained, inasmuch as the considerable change of focus required in order to see them at all renders it impossible to distinguish the ruled lines and such floating objects at the same time. With the eye-piece micrometer, however, this difficulty is removed, and the unit square is clearly in the field of vision without reference to the plane in the cell upon which the objective is focussed.

The working objective for these counts may be either a two-thirds or one-half inch, and for identification of minute unknown forms a one-fourth or one-fifth water immersion capable of working through a thick cover glass and cell, one millimetre in depth would be useful. I have, however, no experience with a high power objective of this character, and can only cite the opinion of our Rochester opticians that such an objective of satisfactory correction and definition can be made.

In the foregoing I have mentioned Prof. Sedgwick as the author of the original method, and have spoken of it as essentially his. It is due, however, to other gentlemen to say that while Professor Sedgwick's work in the way of making the method of practical value does undoubtedly entitle him to the honor of having it bear his name, nevertheless, like all useful advances, it is the work of more than one person.

Mr. A. L. Kean first used a small cell, made to contain 1 cubic millimetre, early in the winter of 1888–89, and attempted by the use of such a cell to arrive at a quantitative determination of the number of organisms present in a given sample. Such a cell was found to be altogether too small to furnish other than uncertain results, although it probably suggested the larger cell which has become of great value. The use of sand as a filtering medium for this purpose was suggested by Desmond FitzGerald, Resident Engineer, Western Division Boston Water Works, but it was to the ingenuity of Professor Sedgwick that

FIG. 3.—COMPLETE APPARATUS FOR BIOLOGICAL EXAMINATION OF WATER.

we owe the working out of the really useful application of those various devices. My own subsequent improvements, which are in the nature of refinements of technique, are fully set forth in this paper.

The practical value of a method of this character will be readily recognized by all who understand the limitations of chemical analysis as applied to the decision of questions relating to the sanitary value of potable water. The most useful of the various chemical methods recognizes only two classes of organic impurity, namely, free and albuminoid ammonia, and groups every organic substance occurring in water as one or the other of these. This has resulted in the condemning of the waters of mountain streams by chemists who ventured positive opinions as to sanitary value on the evidence of chemical analysis alone. The use of the biological method, by exhibiting clearly the character of the organic contamination, will, therefore, lead to a more accurate knowledge of potable waters than can be gained by chemical analysis.

Moreover as we gain more knowledge of the real sanitary significance of the various forms of plant and animal life, the daily or weekly fluctations in quality of a public water supply can be quickly obtained by the use of this method of biological analysis, and it is probable that in the very near future all public water supplies in this and adjoining states will be regularly subject to such examinations. Indeed the State Boards of Health of the States of Massachusetts and Connecticut have already begun a series of examinations, either weekly or monthly, in their respective states, and in the city of Boston I have been engaged a portion of my time for the last eight months in supervising the details of beginning an elaborate study of this kind as applied to the Boston supply. The Boston Water Board, with liberal foresight, have recognized the value of such new methods of examination, and have provided liberally for a practical test extending over a number of years. Daily records have been made for the last six months and show results of great value, though the full value of such work can hardly be determined in so short a time. At a recent meeting of the New England Water Works Association, Mr. F. F. Forbes, Superintendent of the Brookline, Massachusetts, Water Works, has given an interesting account of some similar studies which he made during the last season, with his results, and I will refer those interested to the Journal of that Association for further detail of such work.

The following table shows the comparative value of the open cell with mixed sand and organisms, and the covered cell with sand and organisms separated. The results are in number of organisms per c. c., and represent only the plant forms present in the given samples.

NAME OF ORGANISMS.	(1)		(2)	
	Open cell with sand.	Closed cell without sand.	Open cell with sand.	Closed cell without sand.
Asterionella,	14	30	7	23
Tabellaria,	11	21	4	15
Cyclotella,	1	1	0	2
Anabaena,	2	16	7	13
Clathrocystis,	4	6	1	8
Cœlosphaerium,	5	12	5	3
Nostoc,	0	2	1	1
Melosira,	2	20	1	1
Totals,	39	08	26	66

Table No. 2.

.... WATER WORKS. BIOLOGICAL EXAMINATION OF WATER.

Sample from .... Date of Collection .... Amount Collected .... Date of Examination ....

Grade of Surface .... Collected by .... Amount Examined .... Examined by ....

Grade from which Sample is taken .... Temperature ....

	ANIMAL LIFE.																		PLANT LIFE EXCLUSIVE OF ZOOSPORES.															
Name of Species.	Sponge Spicules.	Statoblasts of Polyzoa.	Fresh-water Polypes.	Rhiza-pods.	Total.	Infusoria.	Total.	Rotifera	Total.	Entozoa.	Total.	Crustacea.	Total.	Miscellaneous.	Total.	Total Animal Life.	Amorphous Matter.	Zoospores.	Desmids.	Total.	Diatoms.	Total.	Chlorophyceæ	Total.	Cyanophyceæ.	Total.	Algæ-fungi.	Total.	Fungi.	Total.	Miscel-laneous.	Total.	Total Plant Life.	No. of Square.
1																																		1
2																																		2
3																																		3
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38																																		38
39																																		39
40																																		40
Totals																																		
No. per C. C.																																		

Remarks:

Rafter, on Biological Examination of Water.

I have recently made a number of similar comparative counts with the result of uniformly getting a larger number of organisms per unit of volume, by the method here described.

The following table shows a number of counts of samples from different localities, and illustrates the variations in number and kind of organisms which will be found in various waters. In this table the results are grouped in classes to save space, and are the number of organisms per c c. as before.

No. of Sample.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sponge Spicules, .	1	1	0	0	0	1	1	0	3	0
Rhizopods, . . .	0	2	0	0	0	1	0	1	1	0
Infusoria, ...	5	2	6	80	21	50	16	0	10	11
Rotifera, ...	1	1	0	0	3	6	1	0	2	3
Crustacea, . . .	0	0	0	0	0	1	0	0	0	0
Total Animals, .	7	6	6	80	24	59	18	1	16	14
Desmidieæ, . . .	0	1	1	0	3	4	5	0	1	1
Diatomaceæ, . .	50	6	12	2	19	45	50	8	17	35
Zoospores, . . .	130	51	73	280	244	88	2400	26	132	90
Chlorophyceæ, .	2	5	4	1	55	13	1	0	1	5
Cyanophyceæ, . .	15	38	70	4	157	110	0	0	0	10
Algæ-Fungi, . .	3	1	0	0	0	0	0	0	1	2
Total Plants, . .	200	102	160	287	478	260	2456	34	152	143
Amorphous Matter,	80	75	140	180	238	230	45	165	170	240

In these samples (8) is from a spring and represents very pure water. All of the samples except (5), (6) and (7) are from water supplies and represents waters of medium quality. The large amount of Cyanophyceæ in (5) and (6) might of itself in the present state of our knowledge lead to the rejection of those two waters as unfit for domestic purposes, especially, if continuous observation, extending over two or more seasons, showed that such extensive growths occurred frequently. In all such cases however a study of the environment would be desirable before making a final decision, and I do not wish to be understood as now saying positively that a given sample can be definitely rejected on the evidence of the biological examination alone. Of this phase of the question I also omit extended discussion here, as I have recently given it consideration in a paper before the American Society of Civil Engineers.

Plate 2 is a form for record of results at about one-half the size to be used in actual practice. This record sheet may be taken as representing a fairly complete form for all classes of work while for any given water supply probably a less elaborate sheet will answer every purpose.

The paper was discussed by Prof. S. A. Lattimore, Dr. J. L. Roseboom, the President and others.

MARCH 24, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Forty persons present.

MR. J. E. PUTNAM exhibited and explained the working of an audiometer devised by him, it being a modification of the Hughes induction balance. Remarks were made by Prof. Lattimore concerning some peculiarities of hearing.

An illustrated paper was read on

THE FUNGI OF WESTERN NEW YORK,

BY DR. CHARLES E. FAIRMAN.

In the introductory portion of this paper a review of the progress of mycology in the United States was given at length, and a resumé of the work of the late Hon. G. W. Clinton, of Buffalo, the pioneer investigator of the fungi of this section. A synopsis of the contributions of Clinton, contained in the Reports of the New York State Museum from the 23rd to the 39th, ended the historic treatment of the subject.

For the past five years the author has been investigating the mycologic flora of Orleans county, N. Y., and has collected over 425 different species during that time, which may be classified as follows :

Pyrenomycetes,	87	species.
Sphæropsideæ,	61	"
Hyphomycetes,	43	"
Hymenomycetes,	96	"
Gasteromycetes,	7	"
Phycomycetes,	10	"
Myxomycetes,	17	"
Uredineæ and Ustilagineæ,	51	"
Discomycetes,	24	"
Imperfect and unclassified,	29	"
	425	

In the fungus flora of Orleans county, so far as known, the Hymenomycetes, or mushrooms and their allies, head the list with the greatest number of species, viz: 96, or nearly one-fourth the number of recorded species. The Pyrenomycetes come next with 86 species. The Hymenomycetes, being mostly of large size, were collected rapidly at first, while members of the other orders, for the most part microscopic, were overlooked. Lately, however, the Pyrenomycetes are coming to the front and will, doubtless, greatly outnumber the other fungi when our mycologic flora has been thoroughly investigated. The list of fungi found in Orleans county includes forms new to the state or, at least, not enumerated in the reports of Prof. C. H. Peck, and several new species and varieties which are set forth at the conclusion of this article. (One of the rarer forms is *Pleospora subsulcata*, E and E. See plate 4, fig. 1 and 2.)

All of the families into which Prof. Saccardo divides the Pyrenomycetes are represented in the mycologic flora of Orleans county except one (the Microthyriaceæ). Nearly forty (40) genera are found in the list of black fungi, the common genera, *Valsa*, *Hypoxylon*, *Eutypa*, *Rosellinia*, *Diatrype* and *Diaporthe*, having the greatest number of species to their credit. The "black fungi" previously mentioned belong to the saprophytes and exist on dead and decaying substances.

We now turn to consider some species of Pyrenomycetes which are parasitic on living plants, the mildews or Perisporiaceæ, the first family of Pyrenomycetes in the *Sylloge Fungorum*. Since the publication of Vol. I of Saccardo's Sylloge, there has been published a paper on the "Mildews of Illinois," by Dr Burrill, which reduces many species of the former work to synonyms. Our mildews (Orleans county) by the arrangement adopted by Peck in his reports, or by Saccardo in the Sylloge, are 19 in number, and by the revision of Burrill became reduced to 14 species. Among the host plants in Western New York attacked by mildew, we find cherry, horsechestnut, grape, lilac, honeysuckle, phlox, violet, larkspur, woodbine, aster, viburnum, elder, elm, beech, maple and gooseberry. The mildew on *Agrimonia eupatoria* (which has heretofore been referred to *Sphærotheca Castagnei*, Lev.) is called by Burrill *Sphærotheca Humuli*, (D. C.). Lyndonville specimens of a *Sphærotheca* on common agrimony show perithecia larger, appendages shorter and more delicate, ascus and spores larger than the common *S. Castagnei*. Therefore *Sphærotheca Humuli* (D. C.), Burrill, seems an appropriate name for our species (Plate 3, fig. 6).

The Sphæropsideæ have sixty (60) representatives which are distributed in many genera, the principal ones being *Septoria*, with 13 species, *Diplodia*, 8, *Sphæropsis* 5, *Phyllosticta* 4. *Pestalozzia* is represented by one species, the rare *Pestalozzia insidens* of Zabriskie, found on elms, which from the beauty and perfection of its spores has been called the "Prince of Pestalozzias" (Plate 4, fig. 9). We find a *Septoria* on common chickweed—*Septoria Stellariæ*, R. and D., and *Phyllosticta Cirsii*, Desm., on Canada thistle, new to the United States, until discovered at Lyndonville. *Haplosporella Nerii* which grows on oleander stems, *Phoma capyrena* on bittersweet branches, and *Phyllosticta filipendulina* on cultivated spiræa are forms which are new to New York State.

The Hyphomycetes are represented in the collection by a number of species (also distributed among many genera) including *Cercospora*, *Fusicladium*, *Ovularia* and *Ramularia*, parasitic on living plants, and *Botrytis* and *Verticillium* on dead or decaying substances. While not exerting as destructive action upon vegetation as some other fungi, this group affords many delicate microscopic forms. Two members of this group, viz: *Fusicladium dendriticum* or apple-peel fungus, and *Ramularia Fragariæ* or the strawberry leaf blight, have been found with us, seriously injuring their respective hosts.

The Hymenomycetes comprize nearly one-fourth the collection, and our flora will be found quite rich in these forms. In the Agaricus family we find many genera present with us, headed by *Agaricus* proper with 22 species, and including members of such genera as *Russula*, *Lactarius*, *Marasmius*, *Coprinus*, etc. The striking feature is that no specimens of the large genus *Cortinarius*, have, as yet, been found, although looked for with assiduity. Elsewhere in the eastern portion of New York State Cortinarii have been plentifully gathered. The family Polyporei is represented by a number of genera and species. A few *Boleti* have been found, in the months of July and August, in our locality, but *Polyporus* has the larger number of species to its credit (about 20).

It may be noted in passing that it has long been known to students of fungi, that *Polyporus applanatus* often attains a large size and that its pores are ferruginous, with a white orifice, which causes the inferior surface of the plant to appear as if white-washed. It has also been known that these whitened surfaces when bruised or scratched show quickly the brown underlying color. I have seen this property made use of in a decorative sort of way, which I have nowhere seen mentioned. Pictures of trees, houses and various objects are drawn upon the white inferior surface of the fungus and are permanent. In many country houses these prepared objects are found plentifully adorning mantels and bric-a-brac receptacles.

Among the Hydneæ we have only the very common genera *Hydnum*, *Irpex*, and *Grandinia*.

The Thelephorei (4th family) are also well represented by species of *Corticium*, *Stereum* and other genera. We have the rare *Corticium lividocæruleum*, Karst, new to the state, and, probably to the country, which agrees with an authentic specimen from Karsten, and a new species, the *Corticium rhodellum*, Peck, of a beautiful rose color.

The Clavariæ are only sparingly represented by a few common forms.

The peculiar gelatinous family Tremellini is represented by species of *Tremella*, *Exidia* and *Dacrymyces*, which are commonly found on moist hemlock stumps.

The next order of fungi the Gasteromycetes or puff-balls is known only by a few common puff-balls, one member of the offensive Phalloids and *Nidularia pulvinata*, Schw, a species rarely occurring in the state.

The order Phycomycetes is represented by a number of "blights" and "moulds." In wet seasons the blights are a source of great annoyance from the wide spread damage done to field and garden crops. It is only necessary to mention the *Peronospora viticola* or grape blight, and the *Peronospora gangliformis*, DeBy, the lettuce blight, to prove this

The Myxomycetes or slime moulds, a group of remarkable organisms, which have occupied debatable positions in various systems of classification, are represented by 17 species. During the vegetative portion of their life history these organisms consist of naked masses of protoplasm, the so-called plasmodia, variously colored, and possessing the power of changing their forms and places, and hence are said to be motile. Under proper conditions, this protoplasmic vegetative state ceases, and a resting state is entered upon, with the formation of spores in spore cases, or sporangia, which assume resemblances to puff-balls, or other fungi. They have always been objects of great interest not only from their curious life history, but also from the delicacy of their fructification and the beauty of their spores and threads, when investigated by the microscope. We have some of the rare forms of this order, as well as the common genera *Fuligo*, *Trichia* and *Arcyria*. We have also one new species a *Didymium* (*Didymium Fairmani*, Sacc.) found growing on the lower surfaces of leaves of *Smilacina bifolia*, which will be noticed later on.

Taking up for our next consideration the rusts and smuts we find the list includes 51 species. The genera represented are *Æcidium*, *Puccinia*, *Uromyces*, *Phragmidium*, *Melampsora*, *Coleosporium*, *Roestelia* and *Cæoma*. This group is of considerable interest to agriculturists on account of the damage done to cultivated plants. Some of the species in the list belong to common forms, such as wheat rust and corn smut, and others to rare members of the order. Only a few features can be here noted in a general way. We have found only one species of *Roestelia* (*Roestelia lacerata*). These roestelia forms, as proven by the cultures of Halsted, Thaxter and Farlow are the æcidia or cluster cup stage of species of *Gymnosporangium*, or the so-called "cedar apples," which are found upon species of cedar and juniper. The *Roestelia* of our flora was found upon Cratægus leaves, but a search for the "cedar apples". upon Juniper has proved fruitless, nor have I found evidence of the occurrence of species of *Gymnosporangium* in Western New York.

While this review was in course of preparation I noticed along the roadside some patches of *Malva rotundifolia* whose leaves were spotted. A removal of some of the spotted leaves and a microscopic examination enables me to announce the unfortunate presence with us of *Puccinia Malvacearum*, or as it is commonly termed, the hollyhock disease. And next I examined my hollyhocks and found them attacked. There are many features of interest about this parasitic rust. When first reported from Australia it was said to be very destructive. It has been recorded in this county in scattered localities in Vermont, Massachusetts and California, and unfortunately seems to be spreading. It has only recently been found in this state. Some specimens were lately sent to Prof. Peck, from Geneva, which he has pronounced to be this fungus, and in an article in the "Country Gentleman" recommended prompt measures to be taken for its suppression ; but it probably has secured too firm a foothold to be stamped out. "As far as the attacks on *Malva rotundifolia* are concerned it may be a good thing, but not so with its attacks upon cultivated hollyhocks," says Prof. Peck in a recent letter. Prof. Farlow of Harvard College, has compared our specimens with others and pronounced them as the same fungus found in Massachusetts, Vermont and Central New York. "The spots are much lighter colored than the Western and California form which is not the true *Puccinia Malvacearum* but *Puccinia Malvastri*, Peck." The color of the latter is black brown, while that of the former is yellow brown. The depth of the apparent color in *P Malvacearum* is dependant to some extent on the fact of the production of promycelia or not, as this species is a member of the sub-genus in which the spores germinate at once *in situ*, if the promycelia are just starting the color appears lighter, if they have not begun to appear it is somewhat darker. (Sec. Farlow in litt.)

PLATE 3.

Pseudovalsa Fairmani, E. and E.

Fig. 1. Portion of hickory bark with fungus (slightly enlarged).
Fig. 2. An ascus and sporidia.
Fig. 3. Sporidia.

Pycnidia state of the above named *Pseudovalsa*.

Fig. 10. A branched sporophore, with two pycnidiospores.
Fig. 11. Another form of pycnidiospore.

Phoma Lyndonvillensis, *Fair.*

Fig. 4. Spores of the fungus.

Haplosporella Ailanthi, E and E.

Fig. 5. Group of spores.

Sphærotheca Humuli, Burrill.

Fig. 6. *Ascus* and *Sporidia*.

Didymium Fairmani, Sacc.

Fig. 7. *Flocci* and spores.
Fig. 8. Crystals.
Fig. 9. Leaf of *Smilacina Bifolia*, with groups of the *Didymium* (Nat. size).

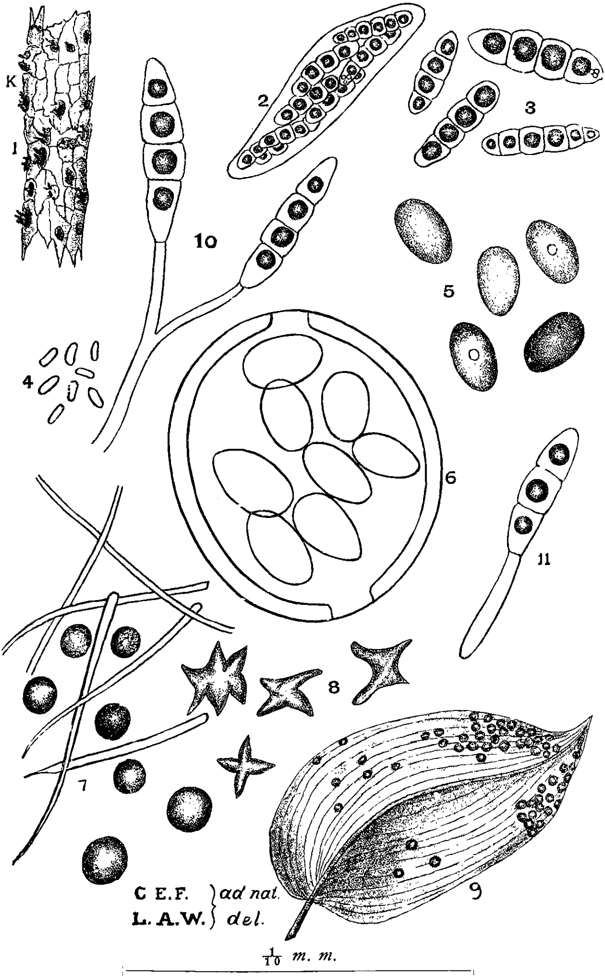
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PLATE 4.

(Scale the same as Plate I.)

Pleospora subsulcata, E. and E.

Fig. 1. Ascus and sporidia.
Fig. 2. A sporidium (*involved in mucus*).

Sporidesmium toruloides, E. and E.

Fig. 3. Spores of the fungus.

Mucor Tæniæ, Fairman.

Fig. 4. A sporangium.
Fig. 5. Spores.
Fig. 6. Hypha with contracted contents.

Anthostomella eructans, E. and E.

Fig. 7. Ascus with sporidia.
Fig. 8. A group of sporidia.

Pestalozzia insidens, Zabriskie.

Fig. 9. Two spores of the fungus.

Lophiostoma Pruni, E. and E.

Fig. 10. A single sporidium.
Fig. 11. An ascus with sporidia.

Didymosphaeria accedens, Saccardo.

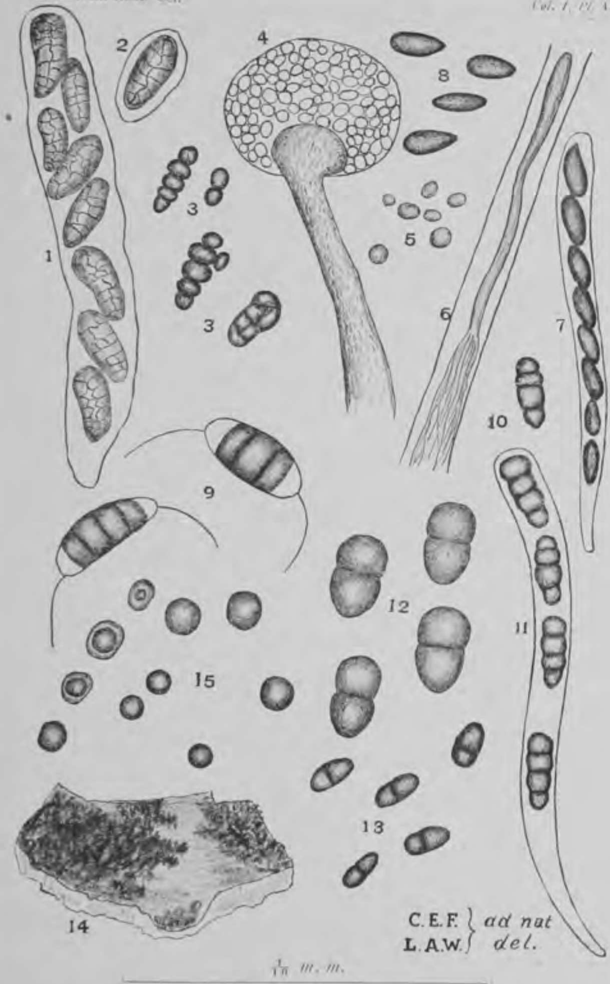
Fig. 12. Sporidia of the fungus.

Diplodia spiræicola, E. and E.

Fig. 13. Spores of the fungus.

Coniosporium Fairmani, Saccardo.

Fig. 14. Rind of squash (nat. size) bearing the fungus.
Fig. 15. The spores of the *Coniosporium*.



Fairman, on Fungi of Western New York.

Among the Discomycetes we have a wide range of forms from our largest morel—*Morchella esculenta* var *conica*—to the microscopic *Pezizas*. The genera represented are *Peziza*, *Morchella*, *Propolis*, *Stictis*, *Patellaria*, *Dermatea*, *Tapesia*, *Encœlia*, *Helotium*, *Ascophanus* and *Ascobolus*. Our earliest species is *Peziza coccinea*, Jacq., which occurs at the same time as the spring beauty (*Claytonia*) and the *Hepatica*. Some of our species are quite rare, as for instance *Tapesia Rosæ*, (Pers.), found on dead stems of wild rose. Mr. Ellis, to whom specimens were sent, says that he had never before had *Tapesia Rosæ* from this country. We have also, recently, found a *Dermatea* growing on twigs of *Lindera benzoin*, which is apparently near *D. Viburnicola* Ell. in Torr. Bulletin (*D. purpurea*, Ell. olim).

The following list contains the new species and varieties which we have added to the mycologic flora of Western New York.

1. **Fenestella amorpha,** E. and E.

Jour. Mycol, vol. 4, page 58, vol. 5, page 79.

On fallen branches of hickory (*Carya*) in the spring. We have attempted to trace the development of the sporidia of this fungus in an article prepared for Jour. Mycol, vol. 6, on the "Development of Some Fenestrate Sporidia." See also plates I and II, Jour. Mycol. vol. 6, for figures of the *Fenestella*.

2. **Didymosphæria accedens,** Sacc., *n. sp.*, (Plate 4, fig. 12).

"Peritheciis gregariis, tectis, ¼–⅓ m. m. lat., ostiolo laeve papillato erumpento, nucleo primo albo. Ascis tereti-clavatis 120x10 μ., paraphysibus obsoletis. Sporidiis senis octonisve, ellipsoideis, utrinque rotundatis, 1 septatis, leviter constrictis, 20–22x9–11 μ., fuligineis monostichis. Affin. D. Rhamni et D. incarcerato ostiolo ascisque diversa." Saccardo in litt. Hab. on dead branches of some tree (Ash ?).

April and May, 1889, Lyndonville, N. Y.

3. **Anthostomella eructans,** E. and E., *n. sp.*, (Plate 4, figs. 7–8).

Perithecia gregarious, globose, ½–¾ m. m. diam., with thick coriaceous walls, buried in the wood, abruptly contracted above into a short neck with an obtuse-conical erumpent ostiolum. Asci cylindrical, 75–80x7 μ. (p. sp.) with abundant paraphyses. Sporidia uniseriate, brown, continuous, rather acutely elliptical, 10–15x5–7 μ. (mostly 12x5 μ.). The surface of the wood is uniformly blackened and the sporidia when mature are discharged as in *Massaria*.

On decorticated (maple ?) limb.

Lyndonville, N. Y., May, 1889. Fairman, No. 42.

4. **Lophiostoma Pruni,** E. and E., (Plate 4, figs. 10–11).

Jour. Mycol, vol. 4, page 64. Also figured in Berlese, Icones Fungorum, Fasc. I Part I, Tab. VI, fig. 3.

On *Prunus serotina*, Lyndonville, April, 1888.

5. **Lophiostoma rhopaloides,** Sacc., var. *pluriseptata, n. var.* Differs from the type in having sporidia three to *five* septate, instead of *three* septate.

On dead branches of *Maple*, May, 1889.

6. **Pseudovalsa Fairmani,** Ellis and Everhart, *n. sp.* (Plate 3, figs. 1, 2, 3, 10, 11).

*Stromata convex pulvinate 1–1½ m. m. diam., formed of the slightly altered substance of the inner bark, the surface only sub-carbonized and blackened, not surrounded by any distinct circumscribing line, covered by the epidermis which is pierced by the stout, short, cylindrical or conical ostiola, with smooth or quadrisulcate tips. Perithecia 4 to 8 in a stroma, closely packed, ovate or subangular from compression, about ⅓ m. m. diam. with whitish, waxy contents. Asci (p. sp.) 75–85x20 μ., mostly only six (6) spored. Sporidia oblong cylindrical, yellowish, 3 septate, 30–40x5–7 μ., slightly constricted at the septa. The young stromata contain an abundance of *pycnidial* spores, (about the size and shape of the *ascospores*) borne on stout or branching sporophores about as long as the spores themselves.

On dead hickory limbs (*Carya*), Lyndonville, N. Y.

(In one specimen 5-septate sporidia were found.)

7. **Vermicularia phlogina,** Fairman.

Botanical Gazette, March, 1887.

On leaves of *Phlox divaricata*, Ridgeway, N. Y.

8. **Vermicularia solanoica,** *n. sp.*

Perithecia superficial, numerous, black, 150–175 m. m. in diam. Bristles few, mostly uniseptate, at times continuous, of various lengths, the longer ones gradually attenuated to an acute tip, brownish, with tips subhyaline, 75–100 μ. long and 5 μ. wide at the base. Conidia oblong, fusoid, subarcuate 25–30x2½–3 μ. Endochrome light green, continuous or faintly divided near the center, granular, nucleate.

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*In the pycnidial stage the fungus might be taken for a Hendersonula. In this stage the stroma is orbicular, depressed, black outside, whitish waxy, horny within, divided into ovate, globose or angular cells from the surface of which spring the sporophores (40–60x3 μ.) bearing at their extremeties the oblong cylindrical, subhyaline mostly 3 septate sporules (35–50x6–9 μ.) generally slightly constricted at the septa. The surface of the stroma in this pycnidial or the Hendersonula stage is at times indistinctly papillose from the slightly prominent ostiola. This stroma is also seated on the inner bark and erumpent through the epidermis. At first the pycnidial spores are only granular and nucleate, but soon become from three to four septate in the progress of development.

On dead stems of *Solanum dulcamara*, Ridgeway, Orleans Co., N. Y., May, 1889.

This might be referred to *V. Dematium*, but until the limits of that species are fixed we propose this as new.

9. **Phoma Weldiana,** *n. sp.*

Perithecia few, scattered, black, shining, small, oval or rotund. 25–30 μ. diam. Spores oblong, pointed at one end abruptly, or both at times rounded, 10–15x3 μ.

On decorticated wood of *Euonymus atropurpureus*. Lyndonville, N. Y., May, 1889.

Name (Weldiana) after Miss L. A. Weld, who has assisted me in the determination of host plants and in the preparation of the plates.

10. **Phoma albovestita,** *n. sp.*

Cortical spots mostly surrounded by a white zone, most apparent before rupture.

Perithecia small, erumpent, nestling in the inner bark, occasionally clustered, dull black. Spores oblong, ends obtusely rounded. 4–7x1½–2 μ.

On bark of *Juglans cinerea*, May, 1889.

11. **Phoma Lyndonvillensis,** *n, sp.*, (Plate 3, fig. 4).

Occupying faded spots on the stem. Perithecia ostiolate filled with minute oval or oblong sporules, sometimes nucleated, 3–6 μ. diam.

On stems of *Malva rotundifolia*, April, 1888. Found on the stems of plants which had been attacked the previous fall by *Septoria malvicola* E. and M. Both the *Phoma* and *Septoria* may be connected as states of some higher or ascomycetous fungus. In the spring, as early as the snow has gone, one can find, on the green stems of the *Malva*, here and there, bleached or dead spots, generally one inch long on which the *Phoma* grows. There is a *Phoma Malvacearum*, but the above peculiar growth has induced me to separate our plant.

12. **Phoma Rudbeckiæ,** *n. sp.*

Perithecia numerous, erumpent, globose depressed, ostiolate, light black. Sporules oblong, rounded at the ends, 4–6 μ. long, 2–3 μ. broad, hyaline.

On dead stems of *Rudbeckia laciniata*, Lyndonville, N. Y., April, 1888.

13 **Septoria Fairmani,** E. and E.

Jour Mycol., vol. 5, page 151.

On living leaves of hollyhock (*Althæa rosea*), Lyndonville, N. Y., June, 1889.

14. **Septoria malvicola,** E. and M.

Jour. Mycol, vol. 3, page 65.

On leaves of *Malva rotundifolia.*

Prof. Peck has referred our specimens to *Septoria heterochroa*, Desm.

15. **Diplodia spiræicola,** E. and E., *n. sp.*, (*in litt.*) (Plate 4, fig. 13). Spores smaller than either of the described species on Spiraea, measuring 8–10x3–4 μ.

D. Spiraeae has spores 14–20x8 μ., and *D. Spiraeina*, Sacc., has spores 20–22x10 μ. (Mr. Ellis now thinks this species may come under *D. Spiraeae.*)

On dead stems of cultivated *Spiraea hypericifolia*, June, 1889.

16. **Diplodia maura,** C. and E., *n. var.*

Var. *Americana* Ell. in litt.

On dead limbs of mountain ash, *P. Americana.*

17. **Morthiera Thuemenii,** Cooke, var *sphærocysta*, Peck, (*in litt*).

Jour. Mycol, vol. 5, page 79.

On *Cratægus* at North Ridgeway on the County line road between Orleans and Niagara counties.

18. **Haplosporella Ailanthi,** E. and E. (Plate 3, fig. 5).

Jour. Mycol. vol. 5, page 147.

On dead *Ailanthus glandulosus.*

19. **Sphæropsis Lappæ,** E. and E., *n. sp.*

Perithecia scattered, subglobose, ⅓ m. m. in diameter, at first covered by the cuticle, soonerumpent superficial. Sporules elliptical, brown, with a single large nucleus, 15–20x8–10 μ.

On dead stems of burdock (*Lappa major*), May, 1889.

20. **Sporonema pallidum,** E. and E.

Jour. Mycol, vol. 5, page 153.

On decorticated maple, Ridgeway, N. Y., May, 1889.

21. **Sporidesmium toruloides,** E. and E., *n. sp.*, (Plate 4, fig. 3). Forming small (1 m. m.) gregarious, cushion-like, black tufts, sometimes subefused. Conidia various, mostly toruloid, forming simple or branched chains of cells, 12–25x5–7 μ. Most of the component cells divided by a longitudinal septum, or also subglobose 5–7x5–7 μ. This is closely allied to *Septonema toruloideum*, C. and E., and to "*Coniothecium*" *toruloideum*, B. and C., but differs from both of these in its longitudinally divided (muriform) cells, which are also slightly muricate-roughened.

On dead wood and bark of *Cornus*, Lyndonville, June, 1889.

22. **Discella pilosula,** E. and E.

Jour. Mycol., vol. 5, page 153.

On a decorticated maple, Lyndonville, April, 1889.

23. **Septoria divaricata,** E. and E.

Jour. Mycol, vol. 3, page 85, vol. 5, page 151.

On living leaves of *Phlox divaricata*, Lyndonville, N. Y., May, 1889.

24. **Coniosporium Fairmani,** Sacc. (Plate 4, figs. 14–15).

Jour. Mycol, vol. 5, page 78.

Ab affin *C. Apiosporiade* differt conidiis multis minoribus, 5–7 μ. d., globosis, levibus, fuligineis, subinde 1-nucleatis On cortex of Hubbard squash, exposed to the weather, Lyndonville, N. Y., February 10, 1886. The fungus covers the rind with black sooty patches.

25. **Didymium Fairmani,** Sacc., (Plate 3, figs. 7, 8, 9).

Jour. Mycol, vol. 5, page 78.

Dignostitus peridiis, sparsis, sessilibus, floccis hyalinis laxe reticulatis, sporis levibus, 8–10 μ. diam, crystallis eximie stellatis. Columella subglobosa, fuscella.

On the lower surfaces of leaves of *Smilacina bifolia.* Aug., 1886.

In the original publication of the species, named by Dr. Saccardo, there was an error in translation, and I have thought best to insert here the original diagnoses.

26 **Mucor Tæniæ,** *n. sp.*, (Plate 4, figs. 4, 5, 6).

Sporangiferous hyphæ erect, rarely, if ever branched, septate, yellow, 7 μ. diam.

Sporangia globose. brownish or yellow brown, smooth, mostly 40 μ. in diam. Columella elliptical or sub-sphaeroidal, at times with contraction at the base, brownish.

Spores globose, or ellipsoid, light yellow, 3–5 μ. in diam., with smooth epispore. Zygospores not observed.

On segments or joints of tape worm (*Taenia solium*). The fungus forms a felted mat on the affected joints, of a sordid yellow color. At times the hyphae have contents contracted into bands.

The parasitism of the mucor upon the entozoön or intestinal parasite is curious and interesting. It seems to me distinct from *Mucor mucedo* in smooth sporangia and spores, and from *Mucor erectus*, Bainier, by the color of the spores.

27. **Pseudohelotium Fairmani,** (E. and E.), Sacc. page 302, No. 1,262, Sylloge Fungorum, vol. 8.

Peziza (*mollisia*) *Fairmani*, E. and E. Jour. Mycol, vol. 4, page 56.

On inner surface of bark (Oak ?) lying on the ground. Ridgeway and Lyndonville, N. Y., April, 1888.

28. **Helotium fumosum,** E. and E.

On dead stems of *Leonurus cardiaca* and *Lappa major*, May, 1889. Specimens were furnished for distribution in N. A. F.

29. **Camarosporium acerinum,** E. and E., *n. sp.*

Differs from the allied *C subfenestratum*, B and C., in its broader (15–26x8–10 μ.), triseptate spores, and more prominent perithecia.

On dead maple limbs, Lyndonville, N. Y.

C. subfenestratum was described by Berkeley from specimens on *Robinia*, and no other host was given. A form found at Lyndonville, on *Ailanthus glandulosus* would be *C. Berkeleyanum*, (Lev.) of some authors, but Mr. J. B. Ellis informs us that Prof. Farlow, who has the original specimens, says this is scarcely distinct from *C. subfenestratum*. Evidently the three species are very closely allied.

30. **Tubulina cylindrica,** (Bull.) var. *acuta*, Peck, (*in litt.*)

Differs very noticeably from the type in having the peridia *acute* instead of "*rounded*" at the apex. Otherwise no marked differences exist. Hab. on rotten stumps in woods.

The illustrations were drawn from camera lucida sketches, by the author and Miss L. A. Weld.

The paper was discussed by Mr. Baker, Mr. Streeter, the President and others, and a vote of thanks was given Dr. Fairman.

April 14, 1890.

STATED MEETING.

The President, Prof. H. L. Fairchild, in the chair.

One hundred and eighty persons present.

The Council report recommended as follows:

(1.) The payment of a bill for printing.

(2.) The election of the following candidates as active members:

Mr. Robert Cartwright
Mr. D. L. Hayes,
Mr. Charles N. Pratt,
Mr. Charles H. Ward.

(3.) The election of the following persons as corresponding members:

PROF. WILLIAM R. DUDLEY, Ithaca, N. Y.
PROF. CHARLES S. DOLLEY, Philadelphia, Pa.
DR. CHARLES E. FAIRMAN, Lyndonville, N. Y.
DR. GEORGE E. FELL, Buffalo, N. Y.
PROF. EUGENE E. FISH, Buffalo, N. Y.
PROF. DAVID S. KELLICOTT, Columbus, O.
DR. A. C. MERCER, Syracuse, N. Y.
REV. C. H. ROWLEY, Wesford, Mass.
PROF. Henry S. Williams, Ithaca, N. Y.

(4.) The election of the following persons as honorary members:

MR. GEORGE KARL GILBERT, Washington, D. C.
REV. JOHN D. KING, Edgerton, Pa.
PROF. ALBERT R. LEEDS, Hoboken, N. J.
PROF. JOSEPH LEIDY, Philadelphia, Pa.
PROF. JOHN S. NEWBERRY, New York City.
REV. FRANCIS WOLLE, Bethlehem, Pa.

The report of the Council was adopted and the candidates for active membership elected by formal ballot. The names for corresponding and honorary membership were laid over one month, under the rules.

MR. G. K. GILBERT, chief geologist U. S. geological survey, gave an illustrated lecture on

THE NIAGARA RIVER.

In this paper Mr. Gilbert discussed the origin and history of the river, and the complex elements involved in the problem of determining the age of the gorge. The subject was discussed by several members, and the lecturer was given a vote of thanks.

APRIL 28, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Sixty-four persons present.

The President gave a lecture on

METHODS OF ANIMAL RESPIRATION,

which was profusely illustrated with charts and diagrams, and was discussed by Dr. Roseboom, Mr. Bacon and others.

It was announced that the Zoological Section would hold its meetings at the residence of Prof. Henry A. Ward.

May 12, 1890.

STATED MEETING.

The President, Prof. H. L. Fairchild, in the chair.

Thirty-three persons present.

The Council report recommended :

(1.) The payment of certain bills.

(2.) That the Academy make an excursion to Stony Brook Glen, May 30th.

(3.) The election of Miss Ella G. Lawton as a resident member.

(4.) The election of the following members as fellows :

J. M. Davison,
E. E. Howell,
Emil Kuichling,
Franz Mücke,
H. L. Preston.
Frank A. Ward.

The recommendations of the report were adopted, and Miss Lawton elected by formal bollot. The election of fellows was laid over one month under the rules.

The candidates for corresponding and honorary membership named at the preceding business meeting, April 14, were elected by formal ballot.

A paper was read by Dr. Anna H. Searing, on

THE LIFE HISTORY OF SOME OF THE FUNGI.

The paper was discussed by Dr. Roseboom and the President.

MAY 26, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Thirty-four persons present.

MR. E. E. HOWELL exhibited a section of an iron meteorite from Puquios, Chili, which showed upon its etched surface lines of dislocation or faulting. This and other peculiarities of meteorites were discussed by Mr. Howell, Prof. Henry A. Ward and others. Prof. Ward said he had found that meteoric iron cooled much more slowly than pure iron. He also referred to the statements that the Greenland irons which, were once supposed to be meteoric, oxydized much more rapidly under cover than out of doors.

The following paper was read :

THE FORCES CONCERNED IN THE DEVELOPMENT OF STORMS,

BY M. A. VEEDER, M. D.

(*Abstract.*)

A notable feature of the distribution of atmospheric pressure is its belt-like arrangement. In the equatorial regions pressure is relatively low, increasing to a maximum in the vicinity of the tropics, and again decreasing toward the poles. In the northern hemisphere these belts of similar pressure have a common center, not at the pole, but at a point in latitude 70 degrees north and longitude 96 degrees west. Circles described about this point with radii of two, three and four thousand miles in length respectively, define with great exactitude the location of these zones, in the northernmost of which cyclones have an eastward movement, and in the next, anti-cyclones move eastward, but cyclones have little or no progressive movement in longitude, and in the third, which is known as the equatorial cloud-ring, storms remain stationary, or at certain seasons move westward.

The common center about which these belts are arranged is the chief magnetic pole of the northern hemisphere. Auroras likewise are most frequent in a well defined belt described about the magnetic pole at a distance somewhat less than that of the center of the belt of eastward moving cyclones. In the equatorial cloud-ring thunderstorms attain their greatest frequency, being of daily occurrence, thus belting a considerable portion of the earth in this location.

In consequence of the displacement, 20 degrees from the pole, of the center about which these belts are arranged, atmospheric conditions over Asia and the Pacific are quite different from those in corresponding latitudes in North America and over the Atlantic. Areas of low barometer have less progressive movement in longitude in the middle latitudes of the eastern hemisphere than in the western. The Pacific, as its name implies, is the calm ocean, while the Atlantic undergoes ceaseless agitation from a never ending succession of eastward moving storms.

This belt-like distribution of atmospheric pressure is usually ascribed to convection currents generated by the heating up of the equatorial regions by the sun. But on the sun himself there is an arrangement in belts of the commotions in his atmosphere, although there is no heating up of his equatorial regions from an external source. Moreover the coronal streamers visible during eclipses have the precise form and location that would produce solar anti-cyclonic ridges or belts, corresponding to those detected by the aid of the barometer on each side of the equator on the earth

The solar belts in which spots and faculæ are most frequent, change their location in eleven-year cycles, appearing in higher latitudes at each fresh increase, and gradually approaching the equator until the period of minimum is reached. The atmospheric belts on the earth do the same thing, and that too in corresponding years. In the case of auroras the relation is reciprocal, they appearing in lower latitudes in proportion as sunspots attain higher latitudes. But for barometric pressure the relation is direct. Blanford has noted that during the years when the average pressure is high in India, as is usually the case during sunspot minimum, it is low at St. Petersbug, and vice versa. In other words in the same way that the solar corona changes its form, and sunspots change their location in eleven year periods, there is on the earth a re-arrangement of pressure and consequent variation in the behaviour of storms and in the location of the tracks which they follow. When the solar corona is broad and quadrilateral in form, instead of long and narrow as at times of sunspot minimum, the terrestrial anti-cyclonic belts are likewise broadened, extending into higher latitudes, and vice versa.

During the past winter the average atmospheric pressure was persistently high over the eastern Gulf States and Cuba, these anticyclonic conditions being attended by a severe drouth in the latter locality. As the result, for reasons that will appear in the course of the discussion, there was a diversion northward of storm tracks, and cold anti-cyclones were few. The conditions were very similar in Europe, the season there also being regarded as abnormal and characterized by unusual mildness over wide areas far north. The last period of sunspot minimum, the winter of 1879–80, had similar characteristics, the unusually mild winter in the United States in that year being equally memorable with that just passed. At the minimum of 1856 the anti-cyclonic belts were slightly further north than during the past winter, the result being steady cold over the central part of the United States, while it was unusually warm in Labrador.

In the equatorial regions, and during summer, the persistence of anti-cyclonic conditions produces drouths. Thus, during the profound sunspot minimum of 1877–78, the persistence of anti-cyclones in low latitudes was made strikingly manifest by the phenomenal drouths which encircled the entire earth in those years. Such drouths are most seriously felt as a rule in parts of India and China at times of sunspot minimum because of the peculiar situation of those countries in reference to these belts of dry anti-cyclones, whose track across continents is marked by deserts, and across oceans by rainless areas, which oscillate more or less northward and southward in eleven-year periods.

This periodicity is not, however, perfectly uniform and free from interruption. The fact of its existence has been established by a system of averaging, which involves the smoothing out and obliteration of the more transient departures from the normal. Thus at a time of profound sunspot minimum there may be brief outbreaks of increased activity which are concealed in the process of averaging. At the beginning of last March, for example, there was a marked but brief revival of solar activity, the largest sunspots seen thus far this year appearing and being located farther north on the disc than any that have been seen in many years, thus probably marking the very earliest indication of the beginning of a new eleven-year cycle.

It is precisely these exceptional variations from the normal that are most interesting. At the date in March just mentioned there was a most remarkable re-arrangement of atmospheric pressure on a grand scale, which was much the more noticeable because of the strong contrast with pre-existing conditions. Anti-cyclones of pronounced character, for the first and almost only time during the winter, appeared far north in America and Europe, and the severest widespread cold of the winter was experienced on both continents, beginning on the same day.

As was pointed out in the discussion before the Academy in regard to the aurora, *certain earthfelt effects of solar disturbances become

*See Page 18.

manifest on the very days when they appear at the eastern limb by rotation. Applying the methods suggested in that discussion, and judging as to the activity of solar disturbances by their history at successive returns, and by their relation to magnetic and likewise to electrical phenomena, which are reciprocal, as well as by their appearance, it becomes possible to note critical dates and institute an inquiry as to whether such disturbances bear any immediate and positive relation to changes in the distribution of atmospheric pressure.

Following this method, it appears from the International Weather Maps that barometric depressions are, as a rule, at once deepened at all points from which observations are to be had, when active solar disturbances are appearing by rotation at the eastern limb. Anti-cyclones also tend to move eastward at such times. In other words an impulse of some sort seems to be imparted to the entire atmosphere, isobars becoming more crowded, winds stronger, and all meteorological phenomena more intense, changes in the distribution of pressure becoming manifest in due course. At times when such impulses are given in rapid succession their effect does not appear in such strongly contrasted conditions from day to day as when a single energetic outbreak follows a period of comparative calm, as was the case in last March.

From evidence such as that adduced we are justified in assuming, as a working hypothesis at least, that the distribution of atmospheric pressure as a whole may be determined to an important extent by the fact that the earth is a magnet, and that its magnetic properties are variable. Certainly the distribution of the solar atmosphere bears a direct relation to the sun's magnetic condition, the changes in its visible condition being associated directly with variations of magnetic range and prevalence of auroras.

It is not proposed to discuss the details of this hypothesis, but to outline some of its leading features As an illustration of the manner in which it may be worked out in detail it may be proper however to refer to a single point. This hypothesis makes possible a new explanation of the persistence of high pressure over parts of the earth in which winter prevails. It is well known that heat decreases magnetic power, and it is perfectly consistent, other things being equal, that the atmosphere, if controlled by magnetic forces, should attach itself in greater measure to the colder parts of the earth. Thus the belt-like arrangement may be due to the earth's total force as a magnet, and the modifications of this distribution at different seasons may be related to local temperature conditions. Certainly such persistent heaping up of the atmosphere as exists over enormous areas in Asia during winter, without strong winds, in spite of the steep barometric gradient, is a phenomenon that demands adequate explanation.

It remains to discuss the mechanism of storm-action and inquire whether it is consistent with the views here presented. An inspection of any weather map shows that the air flows outward in every direction from centers of high barometer, and that in the northern hemisphere it has a rotary movement from left to right about such centers. It is probable, although not beyond question, that this deflection toward the right is due to the fact that air particles, moving upon each other with very little friction, when advancing toward the equator tend to be left behind, and moving in the opposite direction are projected forward, thus creating a whirl. The effect of the lateral interference of two such rotating anti-cyclones is an antagonism of air currents from opposite directions producing a series of smaller eddyings and whirls from right to left along their line of contact, and likewise producing cloud formation and precipitation. These local whirls derive their energy from the upper currents whose velocity has not been checked by friction with the earth's surface. The direction in which these whirls advance is also determined by the upper currents. Thus tornadoes and waterspouts first appear at an elevation above the surface of the earth and extend downward, whirling about, and at the same time moving forward in a direction determined by the anti-cyclonic circulation. Instead of being due to an uprush of warm air they are in some instances certainly attended by a projection downward of cold air, which has a boring motion, penetrating the lower strata. Thus a waterspout which came aboard of a ship was found to have snow at its center. At the instant a thunder storm bursts forth over any locality there is an immediate fall in temperature and rise of barometric pressure, showing a very decided projection downward of cold air rather than an uprush of warm air. Observations in balloons and on mountain tops have brought to light the fact that the air above storm centers is very cold, and above centers of high barometer very warm. With such a distribution of temperature if the circulation of the atmosphere is due to convection currents it would seem that the direction of the movement ought to be exactly opposite to that which appears on the weather maps.

But according to the hypothesis here outlined temperature and convection currents are of secondary importance. The bringing of warm air from the tropics, or the bringing of cold air from the polar regions, is the effect and not the cause of the re-distribution of pressure.

In other words the atmosphere having been massed together in any particular way under the influence of the forces associated with magnetic induction from the sun, equilibrium is maintained as long as these forces do not vary. As soon as they undergo variation atmospheric equilibrium is disturbed and readjustment begins, in the course of which all sorts of eddyings and other phenomena of storm action will occur, the peculiarities of which are determined in part by the belt-like arrangement to which reference has been made, and in part by local conditions. Thus, storms may occur with or without condensation of aqueous vapor, this being merely incidental to the re-adjustment of pressure carrying air currents across bodies of water or land as the case may be. So storms may become violent without steep temperature gradients, as in the case of tropical hurricanes, or they may be attended by very steep temperature gradients as in many of the severe winter storms on the American continent. In either case the temperature contrast is merely incidental and has little to do with the energy displayed, the real force leading to re-adjustment being of a different though perhaps allied nature.

In general the cyclonic circulation of the winds is subsidiary to the anti-cyclonic. West Indian hurricanes afford a complete illustration of this in all its details. For the most part the line of meeting of the trade winds is close to the equator, and these air currents coming in contact at an acute angle with each other do not produce whirls. In August and September, however, the southeast trade is compelled to cross the equator, and thus acquires a deflection toward the southwest because of the rotation of the earth. The antagonism to the northeast trade thus developed, in the upper atmosphere if not at the surface of the earth, produces whirls which when once formed drift westward, carried along by the relatively stronger northern anti-cyclonic circulation, until the western margin of such an area of high barometer has been reached, when the whirl follows it, recurving northward and slowing down in its progress until at the northern margin it again moves more rapidly passing eastward along the usual track of eastward moving storms. Thus storm tracks and the behaviour of storms in many important regards are determined by their relation to the anticyclonic circulation, which in turn is dependent upon the massing together of the atmosphere in the ways described by forces directly associated with magnetic induction from the sun and its variations.

It is to be noted with regard to the above theory of the mechanism of storms that the eastward movement of anti-cyclones, which occurs at times independently of cyclones, is an anomalous feature that deserves further study. This eastward movement may constitute a clue that will afford still further justification of the views here outlined. It may involve also a serious modification of existing ideas in regard to the influence of the rotation of the earth upon the deflection of air currents, about which there are some questions as yet unanswered. The general drift of the evidence is as above stated.

It is only since modern facilities have come into existence that the adequate study of this subject has become possible. The present purpose will have been accomplished if it shall have been shown that there is a possibility of explaining the variations in the distribution of atmospheric pressure, and in the behaviour of storms in different years, points with reference to which, as far as is known to the writer, no explanation has even been attempted heretofore, at least not in any systematic way.

ADDENDUM: Immediately after sending the above abstract my attention was called to the following item in Nature for June 5th, which had just come to hand. It is a remarkable confirmation of the position taken in my argument:

"Mr. S. H. C. Hutchinson, Meteorological Reporter for Western India, has written an excellent 'Brief Sketch of the Meteorology of the Bombay Presidency in 1888–89.' The meteorology of the year was characterized, Mr. Hutchinson says, by strongly marked deviations from the weather conditions of an average year. Of these, the most noteworthy were, a general rise of abnormal barometric pressure for a considerable period, a general deficiency of rainfall in September, and the scanty rainfall throughout the year. Mr. Hutchinson points out that all these variations are of much practical importance, and, from a scientific point of view, of considerable interest, inasmuch as they confirm the laws or principles deducted from the meteorological data of many past years. These laws or principles are, that the rainfall is deficient when barometric pressure is above the normal height, and excessive when the barometric pressure is lower than usual; that at or about the epochs of minimum solar spotted area, high abnormal barometric pressure movements make their appearance, and that at or about the epochs of maximum solar spotted area, abnormally low pressure movements take place in India and over greater part of the tropics; that cyclones are formed in the trough of a relatively minimum barometric pressure; and lastly, that the number of atmospheric disturbances (in India) is great at the epoch of minimum sunspots."—*Nature, June 5, 1890, page 134.*

Lyons, N. Y., July 5, 1890. M. A. VEEDER.

JUNE 9, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Eighteen persons present.

The Council report recommended:

(1.) The payment of certain bills.

(2.) The authorization of payment by the Treasurer of expenses incurred in publication of Proceedings, not to exceed two hundred and fifty dollars, upon order of the Publication Committee.

The report was adopted.

Upon motion of the Treasurer the list of candidates for fellowship was continued upon the table until the next regular business meeting.

A bill of six and one half dollars for printing notices of meetings was ordered paid.

The President, by request, made an informal verbal report upon the excursion to Stony Brook Glen. Mr. Howell and himself had found above the glen, in the Chemung formation, a bed of fossiliferous rock, apparently an impure limestone, which contained boulder-like masses of fine grained homogeneous limestone.

The origin of the water of the artesian well in Gates, near the city line, was discussed. The well was flowing 300,000 gallons daily, and during the seven days of the preceding week 9,000,000 gallons had been pumped out without making any perceptible effect upon the well, either in its flow, or the chemical composition of the water. The water was quite hard, and with a slight taste and order of sulphuretted hydrogen.

The following paper was presented by MARTIN W. COOKE:

ON THE GENESIS AND NATURE OF THE RINGS OF SATURN.

Remarks were made by A. L. Arey, William Streeter, Charles E. Lee, M. A. Veeder and the President.

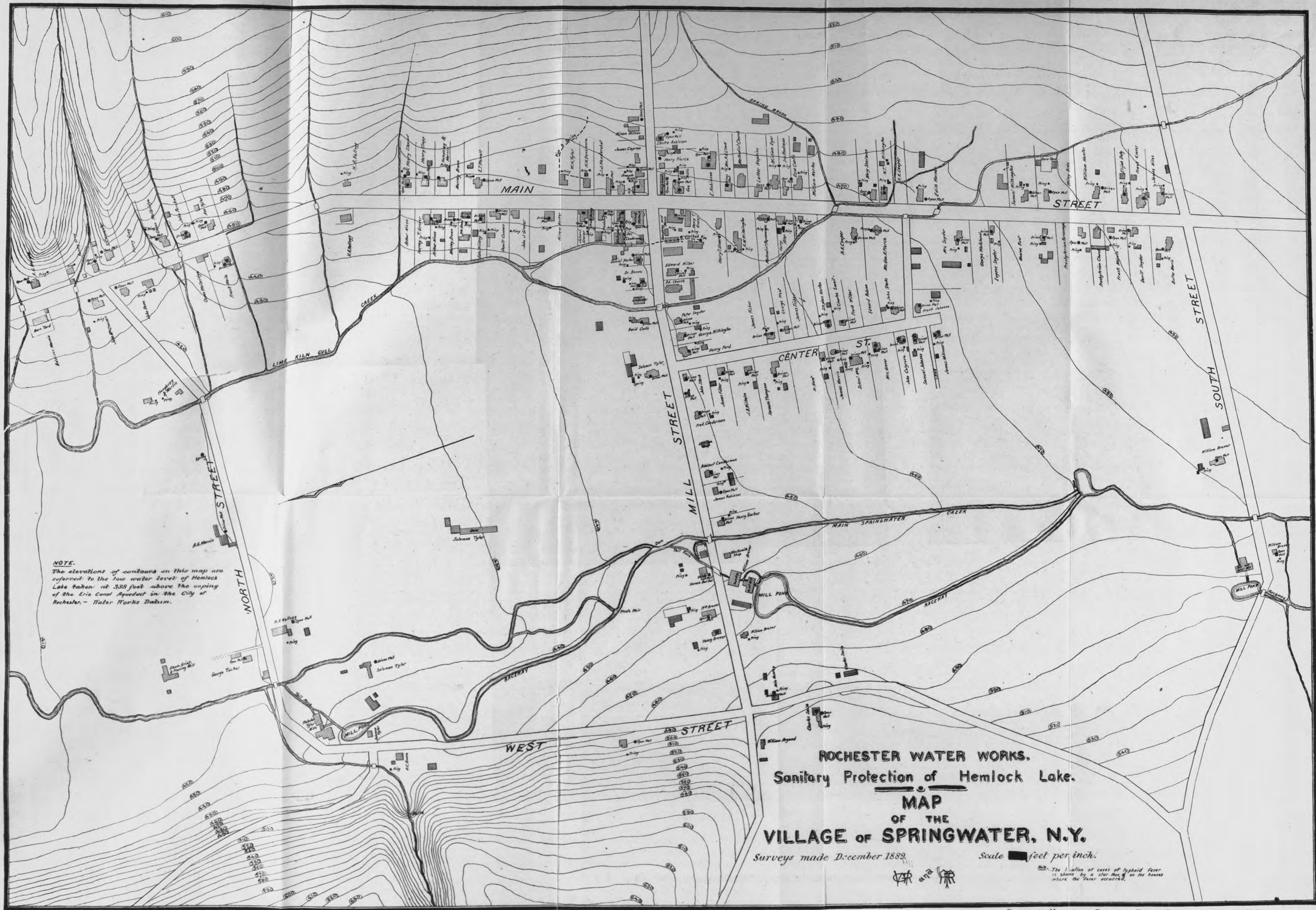
DR. M. A. VEEDER stated that some of the advocates of the "indraught theory" of storms had recently made important concessions, and made remarks supplementary to his paper of the preceding meeting.

JUNE 23, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Thirty-two persons present.


ROCHESTER WATER WORKS.
Sanitary Protection of Hemlock Lake.
MAP
OF THE
VILLAGE OF SPRINGWATER, N.Y.
Surveys made December 1889.
Scale feet per inch.
NOTE.
The elevations of contours on this map are referred to the low water level of Hemlock Lake taken at 388 feet above the coping of the Erie Canal Aqueduct in the City of Rochester.— Water Works Datum.
MAIN STREET
MILL STREET
NORTH STREET
SOUTH STREET
WEST STREET
CENTER ST.
MAIN SPRINGWATER CREEK
LIME KILN GULL CREEK
SPRING BROOK
MILL POND
RACEWAY

MR. J. E. PUTNAM said he had learned that an instrument, similar in principle to the audiometer which he described at the meeting of March 24, had lately been invented in Germany, and was in use for testing the hearing of recruits for the German army.

The following paper was read by DR. M. L. MALLORY:

THE RECENT ENDEMIC OF TYPHOID FEVER AT SPRINGWATER, N. Y., CONSIDERED WITH SPECIAL REFERENCE TO ITS CAUSE, AND THE CONTAMINATION OF THE ROCHESTER WATER SUPPLY WHICH MIGHT RESULT THEREFROM.*

BY GEO. W. RAFTER AND M. L. MALLORY.

Springwater village is situated in a valley of the same name, two and one-half miles south of Hemlock lake, and the unusual prevalence of any infectious disease there is of interest and importance to the people of Rochester, not only because this village is wholly within the Hemlock lake drainage area, but further, because it is situated directly on the main influent stream to the lake. This fact of itself, with the present understanding of the cause and distribution of zymotic disease, is a sufficient justification for a careful study, such as in the present case we have attempted to make.

The Springwater valley, at the village, is nearly two thousand feet in width, with the village of about 600 population mostly at or near the foot of the hill on the east side. The main inlet stream to Hemlock lake flows near the foot of the west bluff, and includes on its course, in what may be taken as the village limits, three millponds with the necessary headraces and tailraces, as shown on the map accompanying this report. These millponds furnish power for two grist-mills and two saw-mills, though at the upper pond little or nothing is done at the present time.

The Lime-Kiln Gull creek flows on the east side of the valley, and for a portion of the way directly in the main street of the village. This is a living stream, although in dry weather there is no flow on the surface through a portion of the village, by reason of the water sinking into the porous gravel forming its bed and flowing underneath the surface. This creek also further receives a number of small streams or gulls flowing u[illegible] directly through the village from the east hill as is clearly shown on the

* [illegible] is the substance of a report made to the Chief Engineer of the Rochester Water Works.

The soil of that portion of the valley on which the village of Springwater stands, is of an open, porous character for a depth of from ten to twenty feet, below which depth are said to be found thin layers of impervious hardpan alternating with beds of quicksand of variable thickness.

The present water supply of Springwater village is derived from shallow wells, either open or driven, the latter being in greater number as may also be seen from the map. As stated by citizens of Springwater, none of these driven wells exceed eighteen feet in depth, and the majority are from ten to fifteen feet. The open wells are quite as shallow, and a measurement of the elevation of the ground water in a number of them, made soon after heavy rains, shows the height of the ground water in the main part of the village at from three and one-half to seven feet below the surface. (See plate 8, profile of Mill street, etc).

Extended discussions of the relation of privies to the wells is unnecessary, as such relation is also clearly indicated on the map. We have no doubt, however, that the proximity of privies to wells has led to a serious contamination of the water used for domestic purposes in many of the families residing in the village of Springwater.

We give the foregoing brief statement of the conditions obtaining at the locality in order that a clear understanding may prevail as to the relation of a serious endemic in the village of Springwater to the health of the city of Rochester, and we deem extended preliminary statement of the matter unnecessary, by reason of the clear showing of the essential physical facts on the accompanying plates 5, 8 and 9.

We proceed, therefore, to a brief discussion of the case in hand:

According to the statement of Robert Wiley, Esq., member of the local Board of Health of the town of Springwater, the first intimation that typhoid fever was present in the village, was on October 19, 1889, at which date some of the local physicians reported the presence of typhoid to the local board. On October 23d, the Town Board of Health convened to consider the matter, and on the following day the condition of affairs was brought to the attention of the Chief Engineer and the Executive Board of the city of Rochester. At the suggestion of the Chief Engineer, Mr. J. Nelson Tubbs, the Executive Board immediately consulted Drs. W. S. Ely and E. M. Moore, Sr., who, on request, furnished the following suggestions as to the necessary inspection and disinfection.

ROCHESTER, N. Y., October 25th, 1889.

To the Executive Board:

GENTLEMEN:—In reply to your inquiry as to the proper measures to be instituted to protect the water supply of the city of Rochester from possible contamination from the presence of cases of typhoid fever at Springwater, we would respectfully state :

That we think all danger can be averted if the discharges from patients suffering from the disease in question, are received in vessels containing a solution of 20 grains of bi-chloride of mercury in a pint of water. After having remained in this solution from 15 to 30 minutes, the discharges should be buried two feet below the surface of the soil, and at a distance of at least 50 feet from all ravines or water courses connecting with the inlet to Hemlock lake. The sheets, linen, flannels, blankets, etc. used by the sick, whenever changed, should be boiled for at least half an hour in a solution made by dissolving four ounces of sulphate of zinc and two ounces of common salt in one gallon of water. All loose articles, without special value, in contact with the affected persons should be burned.

A sufficient number of inspectors should be employed to see that the foregoing recommendations are strictly carried out in the case of every patient affected by typhoid fever, on, or near any stream, emptying into Hemlock lake. It may be best to have this inspection supervised by a medical officer. Reports should be regularly made in writing to your Board, stating the degree to which the foregoing instructions are carried out.

If the measures recommended are immediately adopted we deem that the interests of the community will be advanced by deferring, for the present, any publication of the existence of typhoid fever at Springwater.

It should be borne in mind that the above solution of bi-chloride of mercury, recommended for use as a disinfectant, is highly poisonous, and every preparation containing it should be distinctly marked · "Poison—For External Use Only." We have the honor to be,

Very respectfully yours,

WILLIAM S. ELY.
E. M. MOORE.

Acting under this advice, measures were at once taken for the careful inspection and disinfection of all premises occupied by the sick, as well as for the disinfection of the dejections of typhoid fever patients. These measures included the employment by the city of Rochester of inspectors, to act in accordance with the town Board of Health of Springwater. This action was taken under authority of the rules for the sanitary protection of the Hemlock lake drainage area, as formulated by the State Board of Health, by the provisions of which the local Boards of Health carry out the protective measures at the expense of the municipality protected. In the meantime the present writers were requested to make such studies of the case in hand as might be of use to the water works authorities of the city of Rochester in future efficient protection of the Hemlock water-shed. Such a study was, furthermore, justly deemed of considerable importance by reason of Springwater valley being an unusually healthful region, and the sudden appearance of twenty cases of typhoid fever, in a locality hitherto free from it, appeared to be of sufficient interest to justify the attempt to learn something definite as to its causation.

Our first investigations were, therefore, directed toward a solution of the question of the origin of these cases in Springwater village.

The earliest clearly defined case of typhoid fever, we found to be that of Orson Grover, a boy 13 years of age, who, when taken sick with the disease on September 29th, was employed at Snyder's Hotel, on Main street, near the four corners. Not only is the well at this place in close proximity to the privy (30 feet away), but half way between the well and privy we found a board slop-drain, which, undoubtedly, discharges into the well a considerable portion of its contents. The family claimed, however, that the water of this well had been considered bad for a year and half, and that none of it had been used for domestic purposes during that time; the water so used having been all obtained from the well on the adjoining place to the north. As may be gathered from the map, this Snyder well is in the cellar, and the pump pertaining thereto is in a cellar landing just off the hotel kitchen. We found the pump in working order, with pail beneath the spout, partly filled with water, and with a dipper in the pail. On questioning the servant-girl, it appeared very evident that the water was sometimes used.

The boy, Orson Grover, immediately on being taken sick, went home to the house of his mother, Mrs. R. K. Grover, whose residence is on Center street—first south of the school house. Within fifteen days thereafter no fewer than eight cases appeared among the children in attendance at the village school, and a second son of Mrs. Grover, living at home, was also taken with typhoid fever. In the meantime an adult person, Mrs. Steven Norton, living on the opposite side of the street from the school house, was taken sick, followed soon by the balance of the cases in other parts of the village. (The relation of the privy at Mrs. Grover's residence to her own well, the school house well and other wells in the vicinity is so clearly shown in detail on the map, plate 5, that extended description is unnecessary here.)

The large number of cases among the school children apparently indicated some special source of contagion to which they were exposed, and this special source, we think, is clearly indicated by the foregoing.

The present state of knowledge of the causation of typhoid fever enables us to say positively that the disease is due to the presence, in the human organism of a rod-like bacillus, the so-called *Bacillus typhosus* or Eberth's bacillus; (See photographs, plates 6 and 7 and description of same.) that in the absence of this bacillus the disease cannot exist; that during the course of the disease large quantities of the bacilli pass away from the patient in the dejections; that the usual medium by which this bacillus passes into the human body is drinking water, and that drinking water containing in solution such human wastes as come from slop-drains, cess-pools and privies probably presents conditions favorable for the multiplication of the typhoid bacillus, provided even a single germ gets into such water.

It is also well understood that cases of typhoid fever sometimes occur which are not severe enough to send the patient to bed. These are termed walking cases, and the dejections from them contain the bacilli capable of producing the disease in others, the same as from more severe cases.

Our view as to the origin of these cases of typhoid fever in the village of Springwater is, therefore, as follows: The hotel was certainly an original center of infection, as, including Orson Grover, four persons living there were taken sick with the disease, and while we are unable to establish the fact definitely, we consider it very probable that some walking case of typhoid fever stopped at the hotel, and without leaving any other tangible evidence inoculated the hotel privy with germs of typhoid contained in the dejections. The chemical analyses of the water of the hotel well (see table page 70, or table page 71, and the bacteriological examinations on page 73) both show the water to be exceedingly bad, utterly unfit for domestic use, and the environment is such as to lead, with the certainty of a mathematical demonstration, to the conclusion that there is gross pollution from the privy and slop drain.

From the hotel privy vault, inoculated in the manner indicated, the germs passed, not only to the hotel well, but, possibly, to other wells, and, by use of the water for drinking, to Orson Grover. His presence at his mother's house, and the inoculation of the privy there, caused a further distribution to the school house and adjacent wells on Centre street, whence the germs were quickly distributed to various parts of the village, and in a few cases even to the surrounding country.

Provisions having been made for carrying out the suggestions of Drs. Ely and Moore, as well as for thorough disinfection of the infected privies, etc., we next turned our attention to the quality of the water of the village wells, and as a preliminary step in this direction, the amount of chlorine present in a unit volume of the water of a number of wells was determined by Mr. Rafter. This was done not only because the chlorine determination is easily made, but because the chlorine is a fixed element, free from such changes as take place in the organic matter; and provided we know or can ascertain the *normal* chlorine of a region, the determination of the amount actually present in any suspected water supply becomes on the whole the most satisfactory indication of organic contamination that can be made. The reason for this is the universal presence of salt (sodium chloride) both in kitchen wastes and in human excreta.

The normal chlorine of the immediate region was determined by examining the water of springs and a stream on the east side of the Springwater valley, far enough up the hill to be above any possible source of human contamination, and as a mean of three such determinations the normal chlorine of the natural waters of the Springwater valley is taken for the purpose of this study at 0.13 grains per U. S. gallon.

The following table shows the amount as determined for a number of the village wells, results in grains per U. S. gallon :

DESIGNATION OF WELL.	Chlorine in grains per U. S. gallon Mean of determinations.	Ratio of normal chlorine to amount actually found.
School house well	0.43	3.3
W. H. Pierce "	0.46	3.5
Henry Stewart "	0.67	5.2
—— Waite "	1.25	9.6
Frank Grover "	0.40	3.1
Morris & Grover well	1.00	7.7
E. A. Robinson "	1.54	11.6
Allen & Whitlock "	3.41	26.2
Mrs. R. K. Grover "	0.38	3.0
—— Doty "	1.13	8.7
Daniel Norton "	0.33	2.6
—— Snyder hotel "	7.92	60.9
—— Brophy "	0.44	3.4
—— Hendershot "	5.02	38.6
Mrs. E. Robinson "	0.37	2.9

After making these chlorine determinations we again earnestly repeated to the citizens of Springwater the advice which we gave them on our first visit, namely, to use no well water for drinking or other domestic purposes which had not been brought to the boiling point and kept boiling for at least 30 minutes. The more intelligent people of the village acted promptly on this advice when first given, and to such action on their part must be ascribed in some considerable degree the speedy suppression of the endemic.

The result of our preliminary examination for chlorine was such as to convince us of the desirability of having extended examinations, and after consultation with the Chief Engineer and the members of the Executive Board, a series of samples of the water of such wells as appeared by the preliminary examination sufficiently bad to justify the expense were taken to Professor Lattimore for complete chemical analysis, while two series of samples were forwarded to Dr. H. C. Ernst, of the Harvard Medical School, Boston, for bacteriological and chemical examination.

Professor Lattimore's chemical analyses are given in the following table :

NOV. 30TH, 1889.

ANALYSES OF WELL WATERS FROM SPRINGWATER, N. Y., BY PROF. S. A. LATTIMORE. RESULTS IN PARTS PER 100,000.

DESIGNATION OF WELL.	Whitlock well.	Densmore well.	Morris and Grover well.	Hendershot well.	Mrs. R. K. Grover well.	Steven Norton well opposite school house.	Doty well.	Snyder well.
Identification marks	AA	BB	CC	DD	EE	FF	GG	HH
Total solids - -	44.0	35 2	72.0	88.0	25.2	14.0	30.0	69.2
Loss on ignition - -	20.0	14.0	40.0	32.0	12.0	4.0	12.0	20.0
Fixed residue - -	24.0	21.2	32.0	56.0	13.2	10.0	18.0	49.2
Sodium chloride - -	10.19	6.81	2.49	15.77	0.66	0.66	3.49	26.56
Free ammonia. - -	0.02	0.02	0.03	0.02	0.01	0.01	0.01	0.01
Albuminoid ammonia -	0.02	0.02	0.025	0.015	0.01	0.01	0.01	0.01
Nitrites - - -	none.	none.	trace.	none.	none.	none.	none.	none.
Nitrates - - -	trace.	trace.	trace.	none.	trace.	trace.	trace.	none.

Dr. Ernst was requested to have chemical analysis made of certain of the samples forwarded to him. This was done by Dr. Charles Harrington, of the Harvard Medical School, and the results are given in the following table :

NOV. 10TH, 1889.

ANALYSIS OF WATERS FROM ROCHESTER, N. Y., BY DR. CHARLES HARRINGTON. RESULTS IN PARTS PER 100.000.

DESIGNATION OF WATER.	Lime-Kiln Gull creek, at Advent Church.	Lime-Kiln Gull creek at north end of Springwater village.	Hemlock lake water from inlet well at lake gate house.	Hemlock lake water from city distribution. Tap at Paine Drug Co.'s store.
Identification number -	(3)	(11)	(15)	(16)
Free ammonia - -	0.0003	0.0014	0.0	0.0006
Albuminoid ammonia -	0.0024	0.0046	0.0106	0.0098
Chlorine - - -	0.35	0.37	0.36	0.32
Fixed residue - -	9.00	9.70	4.80	5.30
Violatile residue - -	4.10	4.20	2.90	3.80
Total residue - -	13.10	13.90	7.70	9.10
Nitrates - - - -	absent.	absent.	absent.	absent.

These samples were submitted to Dr. Harrington without any clue to the locality from which they were derived, he having merely the identification numbers as given at the head of the table, and the following extract from his written report is of considerable interest with this understanding.

HARVARD MEDICAL SCHOOL, CHEMICAL LABORATORY,
BOSTON, NOV. 10, 1889.

"I cannot see anything to condemn in any of the Rochester samples, which, from the very close similarity in the chlorine determinations, I infer are from the same general source. Nos. 3 and 11 are, from a chemical standpoint, most excellent waters. In Nos. 15 and 16 there is a marked increase in the amount of organic matter and at the same time a diminution in the residue. This increase appears to be from vegetable matter. Assuming that they are from the same general source, if the increase in organic matter were due to sewage contamination, we would under ordinary conditions expect a coincident increase in chlorine and total residue. I regret that I am unable to give you the exact determination of the hardness. One can, however, form a tolerably correct idea of the hardness from the fixed residue. In no one of the waters can the hardness be high; on the contrary the figures indicate soft waters, Nos. 15 and 16 being the two softest."

CHAS. HARRINGTON.

In the meantime Dr. Ernst made bacteriological examinations of the waters submitted to him, and at the conclusion of his study forwarded the following report:

REPORT OF DR. H. C. ERNST.

JAMAICA PLAIN, Dec. 3, 1889.

November 6, 1889. Nine bottles of water received from Rochester. On the seventh a gelatine-saucer culture was made from each, containing ten drops of water. Three gelatine-plate cultures made from each specimen, five drops of water in each culture. (Saucers and plates were placed in the ice chest until November 11.)

On the twelfth, an examination of the cultures made with the following results:

WATER NO. 1—(School house well)—Saucers and plates were completely liquefied. In both specimens were a large number of non-liquefying colonies. But on account of the liquefaction and the large number of colonies no count was possible, and no further cultures could be made.

WATER NO. 2—(Mrs. R. K. Grover well)—Precisely the same conditions as in No. 1, the liquefaction was so great as to prevent further work on the specimen.

WATER NO. 3—(Lime-Kiln Gull creek at Advent church.)

Saucer liquefied.

Plate 1—Liquefied.

Plate 2—Contained 39 liquefying colonies and 160 non-liquefying colonies.

Plate 3—The same as plate 2.

The pipette used measured twenty drops to one c. c. and therefore the water contained about 800 colonies to one c. c. and a large number of liquefying colonies.

PLATE 6.

PHOTO-MICROGRAPHS OF TYPHOID BACILLI, OBTAINED FROM SAMPLES OF WATER FROM SPRINGWATER, N. Y.

Fig. 1. Cover glass preparation from a culture upon potato. Fuchsin staining. Zeiss "D D." Projection Ocular 2. Gaslight. × circa 450.

Fig. 2. Same as preceding. × circa 700.

Orthochromatic plates.

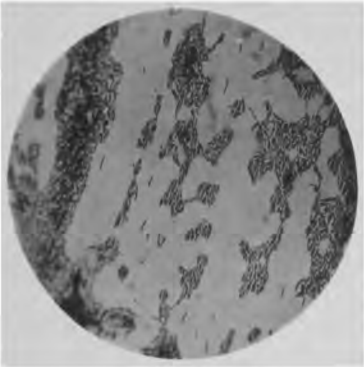


Fig. 1

RAFTER AND MALLORY, ON TYPHOID FEVER AT SPRINGWATER, N. Y.

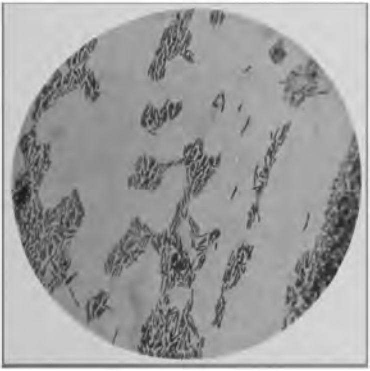


Fig. 2.

Photomicrograph by Dr. H. C. ERNST.

PLATE 7.

PHOTO-MICROGRAPH OF TYPHOID BACILLI, OBTAINED FROM SAMPLES OF WATER FROM SPRINGWATER, N. Y.

Fig. 1. Cover glass preparation from a culture upon potato. Fuchsin staining. Zeiss $\frac{1}{12}$, homogeneous immersion. Projection Ocular 4.

Orthochromatic plate and Oxy-hydrogen light. $\times$ 3000.

Showing vacuoles.

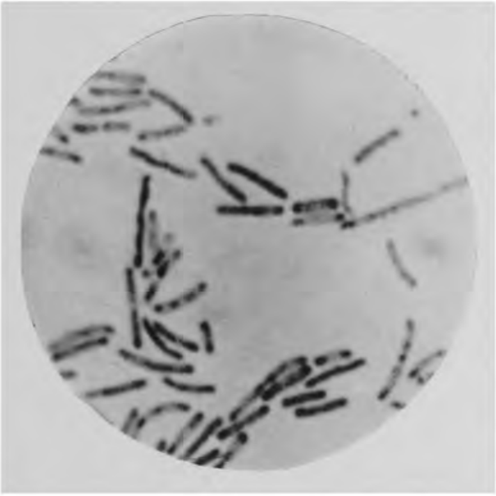


Fig. 1.

Rafter and Mallory, on Typhoid Fever at Springwater, N. Y.

Photomicrograph by Dr. H. C. ERNST.

There were seven gelatine needle cultures made from suspected colonies. On November 18, examination of these cultures showed two liquefying, one a sterile one, and four suspicious. Microscopical examination of these four showed two to be micrococci, and two to be rods. These latter were planted upon sterilized potato, and on Nov. 25 showed an abundant growth with color formation along the needle track and were therefore rejected as not being the typhoid bacillus.

WATER No. 6—(Morris and Grover well.)—The saucer contained numerous liquefying and countless non-liquefying colonies. A few cultures were made.

Plates 1, 2, 3, all showed numerous liquefying and countless non liquefying colonies. A count was impossible and no further culture were made.

Of three gelatine needle cultures made—all showed under the microscope that they were made up of micrococci.

WATER No. 8—(Snyder hotel well)—Saucers and plates were completely liquefied and contained also countless numbers of non-liquefying colonies. No count was possible and no cultures were made.

WATER No. 9—(Doty well.)—Precisely the same as with No. 8.

WATER No. 11—(Lime Kiln Gull creek at north end of village.)

Saucer completely liquefied.

Plate 1. 2000 non-liquefying colonies.
18 liquefying colonies.
(A few cultures made.)

Plate 2. Liquefied.

Plate 3. About the same as No. 1.

The pipette used measured twenty-five drops to 1 c. c., and the water contained therefore about 1,000 colonies to 1 c. c. There were numerous liquefiying colonies, and there were eight gelatine needle cultures made. Microscopical examination of these cultures on Nov. 18, showed that seven of them were made up of micrococci and one of rods. The last was planted on sterilized potato and on Nov. 25 showed a yellow colony and was therefore rejected.

WATER No. 15—(Hemlock lake, inlet well at lake gate-house.)

Saucer liquefied.

Plate 1. 50 small liquefying colonies.
600 non-liquefying colonies.

Plate 2.—100 liquefying colonies.
600 non-liquefying colonies.

Plate 3. About the same as plate 2.

The pipette used, measured 30 drops to the c. c. and the water therefore contained about 4,000 colonies to 1 c. c.

There was a large number of liquefying colonies but not of very rapid growth.

Nineteen gelatine needle cultures were made. Examinations of these cultures showed that there was color formation in two, liquefaction in three, micrococci in twelve, and rods in two. These last two were planted upon sterilized potato, and on Nov. 26, in one there had appeared an abundant yellowish white growth along the needle track, and in the other an abundant growth with a dark discoloration of the surrounding potato. They were both rejected therefore.

WATER No. 16—(Hemlock lake water, city distribution, tap at Paine Drug Co.'s store.)

Saucer. 20 non-liquefying colonies.
4 liquefying colonies.
Plate 1. 12 colonies.
Plate 2. 10 colonies.
Plate 3. 12 colonies.

The colonies were chiefly colored or raised white and porcelain-like in appearance.

An average of twelve colonies to each five drops.

The pipette used measured 25 drops to 1 c. c. and therefore the water contained about 60 colonies to each c. c.

There were five gelatine needle cultures made and an examination of them showed that two were sterile, and three contained micrococci.

A summary of the work upon these first samples of water shows that:

Nos. 1 and 2 contained very numerous colonies, many of them liquefying.
No. 3 contained 800 colonies to the c. c. with numerous liquefying.
No. 6 contained very numerous colonies with many liquefying.
Nos. 8 and 9 the same.
No. 11, 1000 colonies to the c. c. with many liquefying.
No. 15, 4000 colonies to the c. c. with many liquefying.
No. 16, 60 colonies to the c. c., chiefly color forming with a few liquefying.

November 13, 1889, a second batch of waters was received from Rochester and submitted at once to the same sort of analysis as the preceding. From each specimen a gelatine saucer-culture was made—ten drops, and five drops to the culture.

Three gelatine plate cultures were also made from each specimen—two drops to each culture.

All the cultures were made on Nov. 13.

WATER AA.—(Whitlock well.)

Nov. 15—Saucers 1 and 2 not examined because there were too many colonies.

Plate 1. About 50 colonies in each square of the counting plate, —59 squares in the plate—giving about 3000 colonies in each two drops. The colonies were chiefly small, fine round, brownish in color with a few white and opaque, and eleven liquefying—no odor.

Plates 2 and 3 were very similar to plate 1.

The pipette used measured 24 drops to the c. c., and the water therefore contained 36,000 colonies to the c. c.

There were 17 gelatine needle-cultures made.

November 20, examination of these cultures showed that two were sterile, two were liquefying (no odor) and that thirteen were made up of micrococci.

WATER BB.—(Densmore well.)

Nov. 15—Plate 1. *No* liquefying colonies.
17 large white colonies.
520 non liquefying colonies. Most of the colonies appear the same—small, round, white.
Plate 2. *No* liquefying colonies.
24 large white colonies.
622 non-liquefying colonies.

Plate 3. *No* liquefying colonies.
611 non-liquefying colonies.
Saucers about the same as the plates.

The pipette used measured twenty drops to the c. c., and the water therefore contained an average of 6000 colonies to the c. c.

(Note. There were no liquefying colonies—most of the colonies appear to be the same.)

There were eighteen gelatine needle-cultures made.

November 21, examination of these needle cultures showed that one was sterile, one was a prominent white raised colony, and eighteen were micrococci. (All but one of these last were macroscopically and microscopically the same organism.)

WATER FF—(Steven Norton driven well.)

Plates 1, 2 and 3. *No* liquefying colonies.
About 50 large white colonies in each plate.
About 5,000 small white colonies in each plate. Apparently a very large number of the same species.

The pipette used measured 24 drops to the c. c., and the water therefore contained about 60.000 colonies to the c. c.

Four gelatine needle cultures were made, but the colonies were so numerous that an exact isolation of the single colonies was not possible. Two of the needle cultures were made by passing the needle through a mass of many colonies.

Examination of the needle-cultures showed micrococci in all,—there was no apparent difference in the macroscopic or microscopic appearances of the four cultures.

WATER DD.—(Hendershot well.)

Nov. 15.—Saucer (5 drops), 17 liquefying colonies.
50 non-liquefying colonies.
Saucer (10 drops), 32 liquefying colonies.
67 non-liquefying colonies.
Plate 1.—9 liquefying colonies.
12 non-liquefying colonies.
Plate 2.—7 liquefying colonies.
11 non-liquefying colonies:
Plate 3.—11 liquefying colonies.
9 non-liquefying colonies.

The pipette used measured 16 drops to the c. c., and therefore the water contained 165 colonies to the c. c. The colonies were, macroscopically, of different kinds.

There were seventeen gelatine needle cultures made.

November 20, examination of the cultures showed that there were three presenting color formations, six green, fluorescent, and liquefying, two white, liquefying, and with an odor, three micrococci, and *three were rods*. These last three were planted upon sterilized potato, on Nov. 23.

On Nov. 26, two of the potato cultures showed abundant color formation and growth, and were rejected.

The third potato culture showed no color, and no macroscopic growth, but the surface of the potato near the needle track was moist. Microscopical examination of this moist portion showed an abundant growth of the large bacilli characteristic of the bacillus of typhoid fever.

This culture was put through all the forms of nutrient medium, and staining that are necessary for its identifiction, and showed the characteristica reactions in them all.

A summary of the work done npon these last four samples shows that:

Water AA, contained 36,000 colonies to the c. c., with a few liquefying colonies, and apparently large numbers of thé same organism.

Water BB, 6,000 colonies to the c. c., no liquefying and most of the colonies, appearing the same.

Water FF, 60,000 colonies to the c. c., no liquefying, and very evidently enormous numbers of the same organism.

Water DD, 165 colonies to the c. c., about one-half the colonies liquefying, and several kinds of micro-organisms, among them the *Koch-Eberth Bacillus of Typhoid Fever.*

From the face of the results alone, it would be proper to condemn the waters numbered 1, 2, 3, 8, 9, 15, AA, BB, FF, doing this because they all contain a greater number of bacteria to the cubic centimetre than is in accordance with a good standard. But the chemical analysis does not bear out this assertion, nor does the consideration of the conditions found. In general it is true that, water analysed by bacteriological methods and which contains a large amount of bacteria is not to be condemned if there are many of the same kind of organisms present, because in such a case all that we are absolutely justified in doing is to say that that especial organism has found a peculiarly favorable medium for its developement in this sample of water. Now this is just what has happened in the case of all the waters submitted for analysis, that there was found in all of them a marked similarity in the mass of the bacteria found in each specimen, and the excessive numbers found in some of them must be ascribed, in some degree at least, to the delay before the examination was begun, this delay being caused by the distance that the waters had to travel before being submitted to examination.

The water marked "DD" should not be condemned at all for the *number* of bacteria found, but for an entirely different reason, that the *kinds* of bacteria are so numerous among so small a number. The conclusion that I have reached, therefore, was that this water had been contaminated by sewer or other organic matter, and this before the chemical analysis had been made, and it will appear that the chemical analysis had led to the same conclusion.

The excessive liquefaction of the gelatine plates spoken of, means that there were so many of that variety of bacteria—those possessing the power of liquefying gelatine—present in the original fluid that they destroyed any possibility of separating the other forms. The typhoid bacillus does not liquefy gelatine, and its presence may therefore be very easily concealed if there be many of the liquefying forms present. It is also destroyed with comparative ease by the presence of many other organisms, and that is the probable reason that we failed to find it in the water which should have been strongly suspected of its presence, from the clinical history of the cases occurring among the users of it. The importance to be attached to the presence of many liquefying bacteria, more especially if they be of many varieties—is the indication that they furnish of *organic* contamination of the water in which they are found. In this case, it would seem that the conclusion might be drawn—in regard to the waters marked "AA" and "BB" and "FF"—that the number of colonies of the same variety of bacteria, indicated some especial source of contamination, or that especial bacteria found some particularly favorable element for their nutrition in these waters. In any case the failure to find the typhoid-bacillus is not by any means a sign that it was not there originaly, or even at the time when the examination was made ; only, that in the latter case, the number of bacteria present made its detection impossible for us.

HAROLD C. ERNST.

The following is Dr. Harrington's analysis of sample DD (Hendershot well) as referred to by Dr. Ernst. Results in parts per 100,000.

Free ammonia	0.01.
Albuminoid ammonia	0.017.
Chlorine	9.60.

Relative to this sample Dr. Harrington's comment is that it is "distinctly bad."

Professor Lattimore gives in his analyses parts per 100,000 of *sodium chloride*, while Dr. Harrington gives *chlorine* in parts per 100.000. Mr Rafter's results are *chlorine* in grains per U. S. gallon. In order to compare the results we have reduced Professor Lattimore's determinations to *chlorine* in parts per 100.000, and also to grains per U. S. gallon. In the same way Dr. Harrington's determinations of chlorine have been reduced to grains per U. S. gallon. Likewise other analyses made by Professors Lattimore and Leeds have been thus treated. The analysis of Hemlock lake water, by Professor Lattimore, given in the fourth series of analysis on page 78 was presented to the Common Council in a report on the comparative sanitary value of the waters of Hemlock lake and lake Ontario under date of November 22nd, 889. Following is the complete analysis of Hemlock lake water as made by Professor Lattimore at that time, in parts per 100,000.

Free ammonia	0.004.
Albuminoid ammonia	0.006.
Sodium chloride	0.50.
Fixed residue	5.80.
Loss on ignition	4.00.
Total solids	9.80.
Nitrites	None.
Nitrates	None.

TABLE GIVING AMOUNT OF CHLORINE IN WATERS FROM SPRINGWATER, N. Y., AND FROM HEMLOCK LAKE IN PARTS PER 100,000 AND ALSO IN GRAINS PER U. S. GALLON.

Number of Series	Identification Mark.	Designation of Water.	By Whom Determined and When.	Parts per 100,000.	Grains per U. S. gal	Remarks.
(First.)			1889			
	AA	Whitlock Well	S. A. L.	6.17	3.59	For Professor Lattimore's results in *Sodium Chloride* see Table, page 71.
	BB	Densmore "	"	4.13	2.41	
	CC	Morris & Grover Well	"	1.51	0.88	
	DD	Hendershot "	"	9.56	5.57	
	EE	Mrs. R. K. Grover "	"	0.40	0.23	
	FF	Steven Norton "	"	0.40	0.23	
	GG	Doty "	"	2.11	1.22	
	HH	Snyder (hotel) "	"	16.10	9.38	
(Second.)			1889			
	(3)	Lime Kiln gull at Advent church	C. H.	0.35	0.20	
	(11)	" " " N. end of village	"	0.37	0.22	
	(15)	Hemlock lake, Inlet well	"	0.36	0.21	
	(16)	City Mains, Paine Drug Co.'s store	"	0.32	0.19	
(Third.)			1889			
		Tyler Spring	G. W. R.	0.20	0.12	Normal water of the region. Mean = 0.13.
		Another Spring on E. hill	"	0.25	0.15	
		Stream above town to east	"	0.20	0.12	
(Fourth.)			1887			
		Hemlock lake	S. A. L.	trace	trace	
			1881			
		" "	A. R. Leeds	0.19	0.11	
			1889			
		" "	S. A. L.	0.30	0.18	

The fourth series of analyses, as presented in this table, serves to emphasize a fact to which attention was drawn by Mr. Rafter in a paper, "On the Micro-Organisms in Hemlock Lake Water" two years ago, namely, that clearly there is a gradual increasing contamination of Hemlock lake water. At that time only the biological side of the question was presented, but these recent chemical analyses enable us to present with equal clearness the chemical evidence substantiating the same view.

Thus in 1877 the amount of chlorine present was so slight as to give a trace only, as determined by Professor Lattimore. In 1881, Professor Leeds found 0.11 of a grain per U. S. gallon, while in 1889 the amount of chlorine is found to be 0.18 grains per U. S. gallon by Professor Lattimore. At about the same time in 1889, Dr. Harrington determined 0.21 and 0.19 grains per U. S. gallon, or 0.20 as a mean. We must conclude from this close agreement of results reached by two chemists, working independently, that there is no question as to the essential accuracy of the result in 1889.

The great reputation of Professor Leeds and the evident painstaking character of all the work emanating from his laboratory, renders it impossible to successfully impeach his work in 1881, and we are led, therefore, to the belief, that the evidence of an increase in the organic contamination of Hemlock lake water is conclusive.

We urge this for no other reason than to indicate the necessity for strict protection of the Hemlock water shed. The city of Rochester has in Hemlock lake a most admirable water supply, of great natural purity, and the legitimate conclusion to be drawn from such a discussion as the present one is that every effort should be made to keep Hemlock lake, in the matter of purity, in its original state.

The causes of the gradually increasing contamination are (1) the growth since 1877 of a considerable summer population about the lake, and (2) additional soil contamination in the village of Springwater and its consequent influence on the purity of the influent waters of the Springwater creek.

As to the first, we may say that while we recognize the value of the care which has been exercised about the shores of Hemlock lake itself since 1885, nevertheless the presence there of a summer population of from eight hundred to twelve hundred people must inevitably cause considerable organic contamination. Relative to the second source of evident increase of organic contamination, the analyses made last fall by Drs. Ernst and Harrington enable us to present more certain evidence.

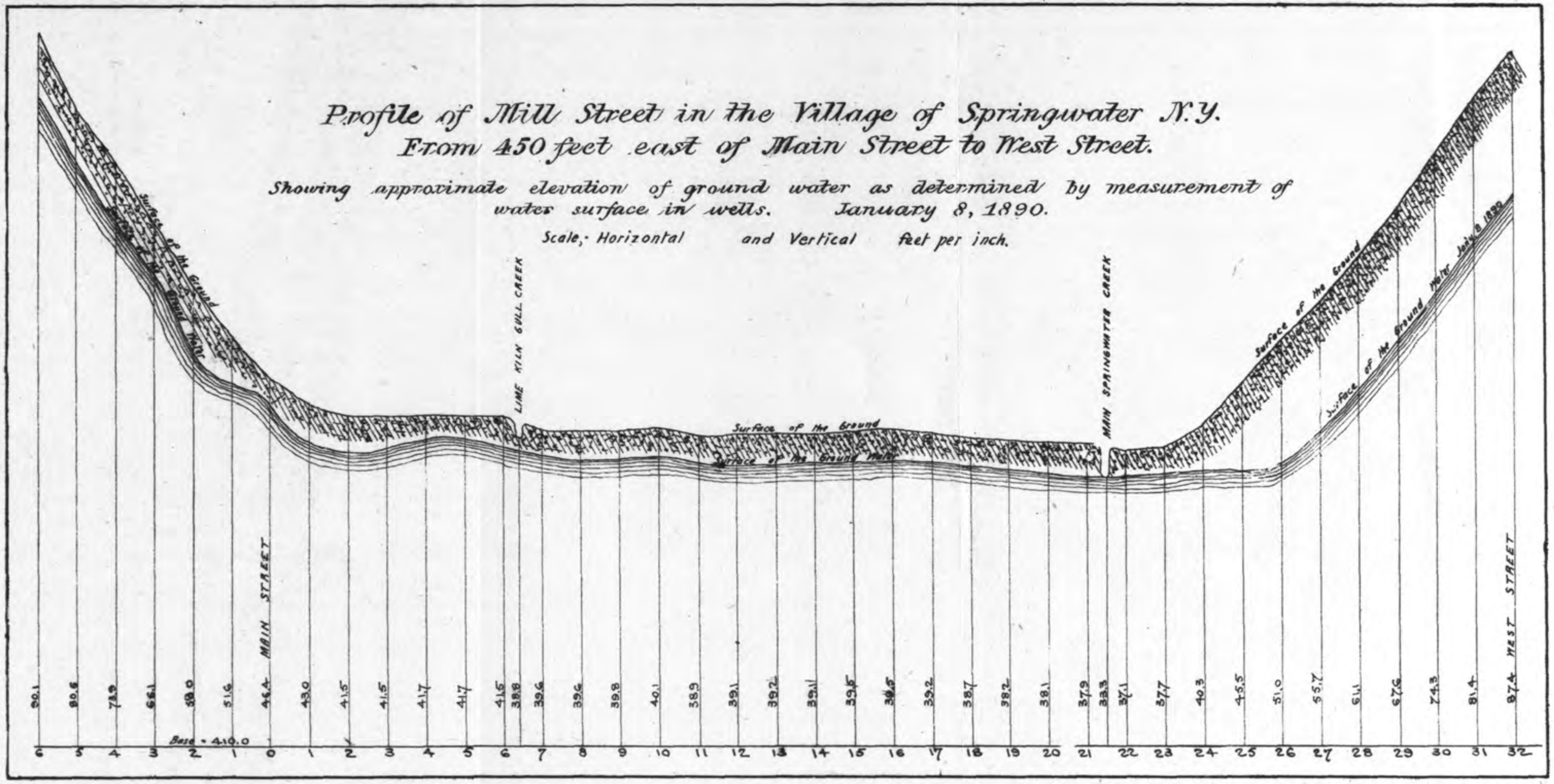
Referring to Dr. Harrington's chemical analysis No. 3, of water from the Lime-Kiln Gull creek, at the Advent church (see table page 71) we find free ammonia present to the amount of 0,0003 parts in 100,000. Analysis No. 11, of water from the same stream at north end of village, gives free ammonia to the amount of 0.0014 parts in 100,000; or, the result of this stream flowing from Mill street to north end of village is an increase of free ammonia four and two-thirds times. Again, albuminoid ammonia at the Advent church was 0.0024 parts in 100,000, while at north end of village it was 0.0046 parts in 100,000; or, albuminoid ammonia was nearly doubled as the result of flowing through Springwater village. In the same way all the other elements show some increase, as, for instance, the chlorine and fixed, volatile and total residues.

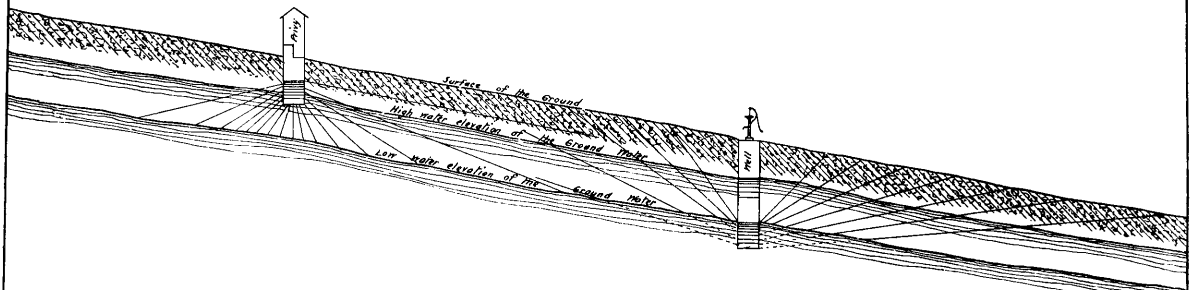
Referring to Dr. Ernst's report on the bacteriological examinations, we find that sample No. 3, from Lime-Kiln Gull creek at Advent church, contained 800 colonies of bacteria per c. c., while the examination of sample No. 11, from same stream at north end of village, gave 1,000 colonies per c. c.

At the time of taking the samples from which these determinations were made the Lime-Kiln Gull creek was a vigorous stream of at least three or four million gallons daily flow. By studying the rainfall record as kept at the foot of Hemlock lake, it is found that there occurred on October 26th and early on the 27th a rainfall of 1.27 inches in 27 hours. Appreciable quantities of rain fell later in the day on the 27th, and also on the 29th and 31st, and on November 2nd there were appreciable rainfalls. The samples submitted to Dr. Harrington were taken on November 4th, and we must conclude from the preceding analysis of the rainfall record that on that date the stream was not carrying excessive quantities of organic matter, due to sudden heavy rainfall after long continued dry weather, but that on the contrary the previous sequence of the rainfall had been such as to leave no other alternative than to conclude that the increased contamination appearing at that time was the ordinary, every-day increase, due not merely to the flow of the Lime-Kiln Gull creek through the village of Springwater, but principally to the material accretions which it received in the course of such flow from the polluted ground water of that village.

With our present understanding of the conditions prevailing, we believe it would be desirable to have the general question here raised somewhat carefully studied, such study to include a series of analysis of samples taken at different times and places, and under such conditions as to preclude the possibility of error. We make this suggestion because we are aware that it is unsafe to reason to absolutely definite conclusions from a single series of analyses, and we believe the question is of enough practical importance to the city of Rochester, as a guide in determining just what remedy to apply to the existing conditions, to justify moderate expenditure in the direction indicated in this discussion.

Plate 8, is a profile of Mill street, directly across the Springwater valley from east to west, and shows the elevation of ground water on that section, as found by actual measurement in the wells on January 8, 1890. Studying it, we easily perceive that not only is the ground water at times very near the surface, but that its relation here to the bottom of the main creek channel is such as to indicate a flow from the higher ground at each side of the creek. It also appears that the bottom


Profile of Mill Street in the Village of Springwater N.Y.
From 450 feet east of Main Street to West Street.
Showing approximate elevation of ground water as determined by measurement of water surface in wells. January 8, 1890.
Scale,- Horizontal and Vertical feet per inch.
Surface of the Ground
Surface of the Ground Water
LIME KILN GULL CREEK
MAIN SPRINGWATER CREEK
MAIN STREET
WEST STREET
Surface of the Ground Water July 8 1890
Base = 410.0



Sketch Showing Relation of Privies to Wells,
and Different Elevations of Ground Water on Sloping Ground.

of the Lime-Kiln Gull creek at Mill street is above the ground water, and the well known fact, that while this stream is always flowing further to the south, the section through the village from Mill street to Main street is frequently dry, serves to indicate forcibly that considerable quantities of water flow from the village toward the main creek.

Below Mill street, to the north, it appears probable that the elevation of the ground water is about the same as the bottom of the Lime-Kiln Gull creek, and this further agreement of physical fact with the results of chemical and bacteriological analysis is an additional argument in favor of the truth of the evidence of increased contamination of the water of this part of the Lime-Kiln Gull creek, as presented in the preceding.

Plate 9 is to scale, and illustrates the actual relation between a privy, the ground water, and one of the village wells. This plate illustrates a typical case, and is the prototype of a number of others in the village.

The germ theory of typhoid is so firmly established by actual experimental evidence that all who are fully conversant with the evidence now admit its validity, and we are therefore at once confronted in such a study with a very pertinent question; namely, assuming it to be true that a portion of the ground water of the village of Springwater was in October and November last permeated with typhoid bacilli, and further assuming that the ground water carrying such bacilli flows directly into the Springwater creek, what is the probability of these bacilli ever arriving in a living state at Rochester?

Stating the case in this way at once brings us to consideration of the length of time that pathogenic germs will survive when placed in potable water, in which presumably the ordinary bacteria of putrefaction are present. Professor S. G. Dixon, of the University of Pennsylvania, has recently experimented on this point and found that the bacilli of typhoid, placed in Schuylkill water, lived not longer than five days. This result, it is concluded, was produced by the antagonism of the bacteria of putrefaction which the water contained, they having, by virtue of superior numbers, either crowded out or actually consumed the bacilli of typhoid.

We note, however, that Professor Dixon experimented with pure cultures of the typhoid bacillus. It is not unlikely that typhoid bacilli finding their way into potable waters enveloped in masses of fæcal matter might live a much longer time than five days, by reason of this environment.

The foregoing answers one part of the question, and the answer to the balance will be found in determining how long a period of time would elapse after such bacilli passed into the creek at Springwater village before they could arrive at and be distribued through the mains in the city of Rochester.

The fall of the creek from Springwater village to the head of Hemlock lake is about 60 feet in a distance of a little over three miles by the creek, or say 16,000 lineal feet. Assuming a mean velocity of flow of one foot per second, the time required for water to flow from Springwater village to the head of Hemlock lake will be 16,000 seconds, or say 4.5 hours. The record kept at foot of Hemlock lake shows that southerly winds prevailed on 21 days in October, 889, and on several of these days the record reads *strong* south winds, probably 20 to 40 miles per hour. In November southerly winds prevailed on 17 days, several of these also standing in the record as *strong* south winds. It is known as the result of ten years of observation at the foot of Hemlock lake, that, when strong south winds do actually prevail, the water is rapidly piled from the south end of the lake to the north end, and it is not unreasonable to assume the velocity of the surface of the lake at one mile per hour, in which case 6.5 hours would suffice for the passage of the germs the whole length of Hemlock lake.

This assumed velocity of one mile per hour, it may be said, is probably considered less than actually takes place at the surface, but as a statement of the mean velocity of the water for a few feet below the surface, due to wave translation, it fully answers the purpose of a general discussion, which is all that is required at this time.

The present compound conduit between Hemlock lake and Rush reservoir is composed of about 50,800 lineal feet of pipe 36 in. in diameter, and 51,500 lineal feet of pipe 24 in. in diameter. The main from Rush reservoir to Mt. Hope reservoir is also 24 in. in diameter and 46,000 feet in length. During the period of time under discussion the conduit was acting direct from Hemlock lake to Mt. Hope reservoir, and discharging at rate of about 9,000,000 gallons in twenty-four hours; or the velocity of flow in 36 in. main can be taken at two lineal feet per second, and in the 24 in. main at four and one-half feet per second. Making the necessary numerical computation from the foregoing data, we find that the time required for passage of water from Hemlock lake to Mt. Hope reservoir is thirteen hours, or the total time from Springwater village to Mt. Hope reservoir may possibly be as short as twenty-four hours. With an allowance for delay in Mt. Hope reservoir we arrive at the conclusion that disease germs, passing into the inlet creek at Springwater village may, if all the conditions are favorable, be distributed to water consumers in Rochester within thirty-six hours.

In further presentation of this view it is but fair to state, however, that the actual passage of typhoid or other disease germs from the head of Hemlock lake to the foot, and thence into the conduit in the manner indicated, would require that during the translation, from head of lake to foot, they remain at or near the surface, and after arriving at the foot sink to a depth of about thirty feet, that being the depth from which the conduit takes water. This additional necessary condition makes the contingency somewhat more remote than would appear at first glance, and we desire to be understood as saying, only, that as the result of studying the physical features of the case, we deem it not at all improbable, that, with the conditions favorable, disease germs *may* pass from Springwater village to the city of Rochester in thirty-six hours.

In the present state of biological analysis it would not be impossible to make an actual demonstration, not, indeed, by placing pathogenic bacteria in the Springwater creek, but by planting harmless varieties which at a given time are known by actual trial to be absent; and by the bacteriological examinations of samples selected at various points determine the rate of progress towards the city, increase or decrease of numbers, and other questions likely to aid in a solution of the general problem. Such an examination could be carried on in conjunction with a study of the contamination of the Springwater creek as already indicated, and we suggest as being of great practical value, not only to the city of Rochester but to all municipalities with public water supplies, that the Executive Board, as being by law the body having charge of everything relating to the water works, make an investigation of the matters here indicated.

In continuation of the view already advanced that septic bacteria are inimical to pathogenic bacteria, we call attention to the considerable number of harmless forms present in the samples of Hemlock lake water submitted to Dr. Ernst. Referring to his report we find that the samples of Hemlock lake water taken from the lake itself contained 4,000 bacteria per c. c., while as already noted the two samples from the Lime-Kiln Gull creek contained 800 and 1,000 colonies per c. c. respectively, and possibly the fact of the presence of these large numbers of septic forms is the reason why the city of Rochester escaped any serious effects from the endemic of typhoid fever at Springwater last fall. That we did escape such serious effects is clearly indicated by the following table compiled from the records of the health department of the city :

TABLE SHOWING ACTUAL NUMBER OF FATAL CASES OF TYPHOID FEVER IN ROCHESTER FROM 1870 to 1889 INCLUSIVE, AS COMPLIED FROM THE REPORTS OF THE HEALTH OFFICER AND RECORD OF THE HEALTH OFFICE :

YEAR.	MONTH.												Totals.	Population.	No. of deaths per 1,000 of population.
	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.			
1870	2	3	3	1	2	1	5	2	12	14	6	3	54	62,386	0,864
1871	3	2	2	1	0	3	3	2	2	7	2	3	30	66,253	0,453
1872	6	1	2	2	1	1	4	8	10	17	8	10	70	70,120	0,999
1873	5	6	4	1	4	2	1	5	5	12	6	10	61	73,987	0,824
1874	1	1	0	1	1	2	4	5	4	11	5	6	41	77,854	0,527
1875	5	4	2	2	3	2	3	2	3	11	4	3	44	81,722	0,538
1876	3	3	3	2	2	1	1	2	2	6	4	2	31	83,250	0,373
1877	2	0	0	2	1	0	0	4	5	5	6	2	27	84,780	0,307
1878	1	1	0	1	4	1	1	3	4	0	0	1	17	86,310	0,197
1879	1	0	1	3	1	1	0	2	1	1	4	2	17	87,840	0,193
1880	1	1	1	1	0	0	1	5	0	7	3	1	21	89,366	0,235
1881	2	0	4	1	0	1	0	2	5	6	4	1	26	95,000	0,276
1882	3	2	0	3	3	1	0	0	4	5	4	5	30	98,488	0,305
1883	8	1	2	1	4	1	0	4	4	6	5	3	39	103,478	0,377
1884	3	0	2	3	1	1	2	2	4	7	9	9	43	108,249	0,397
1885	8	2	1	2	0	0	1	2	5	8	2	1	32	113,169	0,282
1886	1	1	1	3	2	2	1	3	7	5	3	4	33	118,242	0,279
1887	3	2	2	1	0	0	2	2	9	9	5	3	38	123,470	0,308
1888	5	4	1	2	3	1	1	10	14	9	2	2	54	128,832	0,402
1889	1	3	1	0	0	1	5	4	6	8	3	7	39	134,342	0,216
Tot'ls	64	37	32	33	32	22	35	69	106	154	85	78	747		
1890	3	2	3												

We cannot, however, hope to be thus fortunate always, and the resulting uncertainty as to future conditions constitutes a strengthening of the argument for the special studies indicated in the foregoing.

Dr. Henry B. Baker, Secretary of the Michigan State Board of Health, following Pettenkofer, has shown in a paper in the Annual Report of the Michigan Board for 1884 that there is in Michigan a relation between low water in wells and the prevalence of typhoid fever, and while we have no observations as to the elevation of water in the Springwater wells during September and October, 1889, we have compiled, as furnishing a basis for comparison, a table showing amount and distribution of rainfall at the foot of Hemlock lake and elevation of surface of Hemlock lake from May, 1889, to January, 1890, inclusive. From a study of this record in conjunction with the temperature record, (these tables are not given here) it appears certain that while the rainfall was heavy in the early part of the season, the amount and distribution of precipitation was such in August, September and the early part of October as to produce unusual dryness in a region having an open, porous soil, as for instance, the village of Springwater. Such a condition would lead to increase of pollution of the wells by privy drainage, and if the specific bacillus of typhoid fever became present in any way, would be likely to lead to an endemic of typhoid fever.

The recent studies of the causation of typhoid fever have resulted in a material modification of the views held only a few years ago, and this part of the subject as embodying recent work is not only of considerable interest but of great value. The literature of this special department of etiology has however, multiplied so greatly that we do not consider it necessary to go into an extended account here. Those interested in the recent views will find them admirably presented in the Fourth Annual Report of the State Board of Health of Maine, recently issued.

The definite identification of the bacillus of typhoid in the well water from Springwater, by Dr. Ernst, is, however, of more than local interest, inasmuch as this identification has not yet been made sufficiently often to take from a new identification the element of interest which always attaches to a new physical discovery.

Including the identification at Springwater, the typhoid bacillus has been successfully isolated and demonstrated as present in drinking water fourteen times to date. It has also been identified once in air, making fifteen times in all.

Of these fifteen well attested cases of identification, five have been made in this country and two of them by Dr. Ernst. The previous identification by him was in water from filters used in Providence, Rhode Island, and this was further vertified by another bacteriologist (Dr. Prudden) working independently.

Dr. Charles V. Chapin, Superintendent of Public Health, Providence, has given, in the Boston Medical and Surgical Journal for June 20, 1889, an account of this identification at Providence, together with a *résumé* of all the instances of definite identification to that date, from which we have compiled the statement of total number of identifications.

We regret that we are unable to give the detail of each of the cases of typhoid fever occurring at Springwater last fall. We are unable to do this, not only from a lack of disposition on the part of the attending physician to prepare full records of their cases, but because of a lack of appreciation of the importance of such records on the part of the health authorities there. We have, therefore, been obliged to treat the matter in a general way rather than in detail.

The paper was discussed by Dr. Roseboom and others.

The following paper was read:

DESCRIPTION OF NEW METEORITES.

By Edwin E. Howell.

THE WELLAND METEORITE.

A brief notice of this new iron, recently added to the Ward & Howell collection, was given before the Geological Section of the Academy, Feb. 17th. This meteorite was found April 30, 1888, about one and one half miles north of Welland, Ontario, Canada. It was plowed up by Walter Caughell, on land owned by Mr. Shannon, and

Welland Meteorite.
(One-third natural size.)

attracted attention by its specific gravity, but not being considered valuable was thrown one side after a small piece weighing 5 ozs. had, with much difficulty, been broken off. This piece was kept by Mr. Geo. Holland, brother-in-law of Mr. Shannon, until September last, when he gave it to Dr. McCallum, his family physician, who being convinced it was meteoric forwarded it to me. Mr. Holland was in due time engaged to search for the original mass, which he finally found December 9, 1889, in a pile of old iron inside of an old stove oven.

It is impossible to determine the original size of the mass as it has been so long exposed to oxidation that none of the outer crust or characteristic pittings remain, the general form only being preserved, which is that of a kidney shaped mass, as shown in the accompanying cut. There has doubtless been considerable reduction in bulk. The two greatest dimensions of the mass are 8 and 6 inches (20x15 centimeters). After being freed from all loose scales the total weight, including the piece first broken off, was 17¾ lbs. (8 kilograms). At several points the octahedral structure is well shown, and the decomposition of the iron enabled me to collect the taenite in amount sufficient for analysis, which has been given Mr. J. M. Davison for that purpose. A polished section of the iron treated with dilute acid shows the Widmanstätten figures rather coarse and strong, not unlike the Toluca irons.

The entire absence of troilite, as far as can be detected in the various sections, is a marked feature of the iron, the only indication of its presence being the small amount of sulphur shown in the following analysis kindly furnished by Mr. Davison :

ANALYSIS OF WELLAND METEORITE.

Fe	91.17
Ni	8.54
Co	.06
S	.07
	99.84

Specific gravity............7.87

JOHN M. DAVISON, Reynolds Laboratory,
University of Rochester.

June 28, 1890.

THE HAMILTON COUNTY METEORITE.

In June of last year we secured from Prof. Edgar Everhart, of the University of Texas, an iron meteorite which he wrote us was found in Erath Co. of that state. It appears however that the iron was really found in the northern part of Hamilton, the adjoining county. Mr. J. D. St. Clair, of Alexander, Erath Co., who as agent for the discover sold the meteorite to Prof. Everhart, has kindly furnished me with the following facts: In April, 1888, while plowing in his field about five miles south of Carlton, Hamilton Co., Texas, Mr. Frank Kolb struck with his plow what he at first supposed was a stone, but which proved to be the meteorite in question. Whether or not he had any idea of its true nature does not appear, but he seems to have kept it about a year before engaging Mr. St. Clair to sell it for him. When the meteorite reached us it weighed 179 lbs. (81½ kilos) and was entire, with the exception of a few ounces cut off by Prof. Everhart for analysis, which he seems to have not had time to complete. The thinner end had been pounded considerably, and some small fragments may have been detached, so that when found the weight might possibly have been 180 lbs. The two greatest dimensions are 17½ and 13 inches (44x33 centimeters).

The general form is well shown in the accompanying cut. The underside is smoother and less sharply pitted than the upperside, which was probably the forward portion during the latter part of its flight. The iron, although very little oxidized, shows none of the characteristic striæ and ridges seen in irons that have recently fallen.

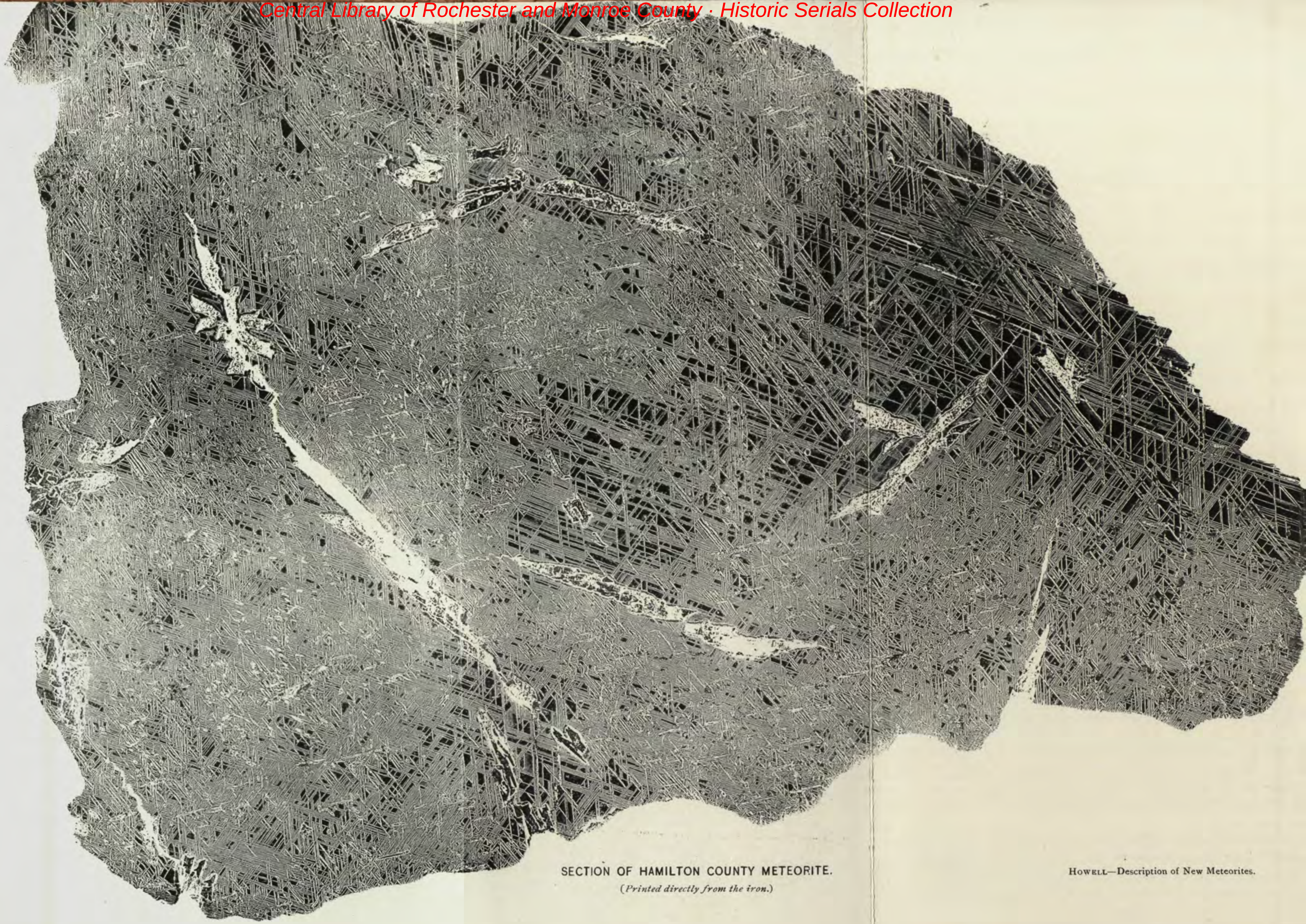
The troilite seems to be distributed in comparatively thin plates, no nodules having been seen. The largest example is six inches in length,

HAMILTON COUNTY METEORITE.

(One-fifth natural size.)

and less then one quarter inch in average thickness, with an unknown width of certainly over two and one-half inches, is quite irregular in outline and terminates at one end in a star with points about one-half inch long. This form, which is very suggestive of certain marcasite crystalizations, seems to be quite persistent, showing substantially the same in different sections for two and one-half inches without any more indication of coming to an end than the plate with which it is connected.

Prof. Josiah P. Cooke, who has examined two of the sections, writes "I do not see any farther signification in the star except the tendency of the troilite to separate along the planes of crystalization, and the union of these planes roughly marked gives the star."



SECTION OF HAMILTON COUNTY METEORITE.

(*Printed directly from the iron.*)

The Widmanstätten figures are brought out with remarkable quickness on the application of very dilute acid, and are surpassed in beauty by no iron with which I am familiar. These are beautifully shown in plate 10, which is printed directly from a deeply etched section. Where the pleissite is most abundant they resemble somewhat the markings on the Trenton and Mumfreesboro irons, but more closely those of the Descubradora. The lines of kamesite are narrower, however, than in any of these irons, and the inclosed figures smaller and more elongated, being in many parts a mere thread 5 to 8 m. m. in length; but in this respect different parts of the same section vary greatly, as will be seen by an examination of the plate.

Some of the inclosed figures are beautifully marked with the fine lines first noted by Dr. J. Lawrence Smith on the Trenton iron, and called by him Laphamite markings. These mostly disappear when the iron is etched deeply, and consequently do not appear on the plate.

The analysis of this and the following iron have been kindly furnished by Mr. L. G. Eakins of the U. S. Geological Survey, through the courtesy of Prof. F. W. Clarke, chief chemist:

ANALYSIS OF THE HAMILTON CO. METEORITE, BY L. G. EAKINS.

Fe	86.54
Ni	12.77
Co	.63
Cu	.02
P	.16
S	.03
C	.11
Specific gravity 7.95 at 27°	100.26

THE PUQUIOS METEORITE.

This iron was purchased by Prof. Ward from the wife of Enrique Ravenna, at Copiapo, Chili, April 26, 1889. According to Señora Ravenna's statement it was found by her husband four or five years before, probably in 1885, near Puquios, and had been kept by them until secured for the Ward & Howell collection.

The iron reached us in an absolutely perfect condition; it had apparently lain for a considerable time half buried in the soil with its upper surface exposed to the weather and drifting sand, which combined to bring out the structure of the iron without oxidation, making an exceedingly interesting and attractive object.

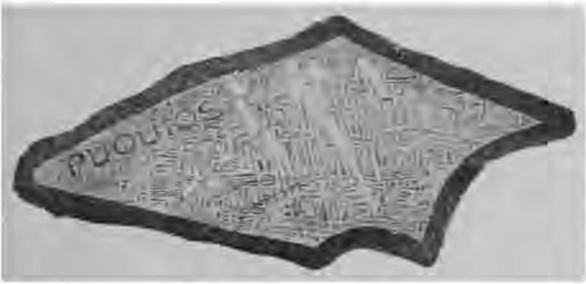
The general form of the meteorite is such as might result from the wearing away of a rhombic prism, and is perfectly shown in the accompanying cut. The surface is unusually smooth, showing only a few shallow pittings. The two largest diameters are 10 and 5½ inches (25x14 centimeters) and the weight was 14 lbs. 7½ oz., or a trifle over 6½ kilos.

Although the surface of this iron is unusually interesting the interior proves to be still more so. The etched sections show that the mass has been subjected to fracture and dislocation, resulting in a distinct and unquestionable "faulting" of the Widmanstätten figures, and of the troilite. Most of these faults are so small and faint that they cannot be reproduced in an illustration, but are clearly seen with a pocket lens. The accompanying cut of one of the etched sections, reproduced by photographic process, shows three of these lines of faulting. These are the especially interesting feature of this meteorite, and, as far as I

PUQUIOS METEORITE.
(One-third natural size. The line a, b, indicates where section was made.)

am aware, are the first faults noted in an iron meteorite. The novelty of this phenomenon, and the exceeding toughness of meteoric iron, making a sharp fault seem almost an impossibility, require that the evidence of such a fault should be clear and conclusive before its acceptance as a fact. And such is fortunately the case. The largest fault is seen in successive sections for two and one quarter inches, or as far as the iron has been cut, and apparently extends the entire length of the mass. The throw of this fault is nearly one eight of an inch (3 m. m.). Careful examination reveals some crushing and branching along this line. Other parts of this section, and other sections, show small fractures with slight displacement. These faults are clearly not the result of the impact of its fall, but are a part of its earlier history. In the light of some experiments made two years ago with Toluca iron, I would suggest the probability that they were made when the iron was very hot,—perhaps in its passage near the sun, I found that a piece of Toluca iron, although very tough when cold, would crumble under the hammer when heated to a white heat. If we assume that the faulting of this meteorite took place under similar conditions of heat, it seems necessary to assume also a contact with some other body.

The Widmanstätten figures call for no special remarks as they are sufficiently shown in the illustration. Suffice it to say that they are produced very readily with weak acid, and the finer lines (Laphamite



SECTION OF PUQUIOS METEORITE.
(Three-fourths natural size.)

markings) crossing the pleissite are unusually well developed, and are sometimes seen running parallel to the adjacent side.

ANALYSIS OF THE PUQUIOS METEORITE, BY L. G. EAKINS.

Fe	88.67
Ni	9.83
Co	.71
Cu	.04
P	.17
S	.09
Si	tr. (?)
C	.04
	99.55

Specific gravity 7.93 at 25.2° C.

THE DE CEWSVILLE METEORITE.

Apparently the only portion of this aerolite which reached our earth in a solid mass is a small stone weighing 340 grms., (about 12 oz.)

The accompanying illustration shows two views of this stone, one-half natural size. It is covered with the usual black crust, which is noticeably thick, and appears to be of equal thickness on all sides, indicating that there was no breaking up in the latter part of its flight. This crust has been broken on some of the sharper corners after it struck the earth, otherwise it is perfect, having been preserved as it was found.

It fell in the village of De Cewsville, Ontario, Canada, about two p. m., Jan. 21, 1887, striking in the ditch on the south side of the street known as the Talbot Road, opposite lot number 43, con. 1. The ditch at the time contained about a foot of water from a recent thaw, which was covered with thin ice. The meteorite made a hole in this ice, I was told, about a foot in diameter. The whizzing noise in the air and the splash in the water were heard, and the latter seen by Mrs. Leonard Strohm, who was walking along the middle of the street and was only about fifteen feet distant. Her first thought was that some one had

(One-half natural size.)

thrown a snow-ball. The noise made by the passage through the air seems to have been heard with about equal distinctness by two men who were engaged in conversation, Mr. Drinkwater and Jacob Strohm, one sitting in his sleigh in the middle of the road and the other by a pump in his barn-yard, on south side of road, about 150 yards west of where the meteorite fell. This fact, together with the further fact that the meteorite after striking the ice and frozen ground in the bottom of ditch seems to have passed three or four feet to the eastward, indicates pretty clearly that it came from the west, and the impression of at least one of the persons who heard it, Mr. Strohm, whom I saw and questioned, was that it came from the west or a little north of west. Search was at once made for the stone by Mr. Strohm and others, but without success, and the spot where it struck was marked by cutting a notch in the fence near by.

After the melting of the snow and ice the stone was found by Wm. Kinnear while on his way to school, on the morning of February 16th, about three or four feet to the east of where it struck. It was sent to me in August of the same year by a friend who purchased it from the boy who found it, and it is now in the Ward & Howell collection of meteorites.

As we have thus far kept it as it was found, no analysis has been made. Its specific gravity (3.52) is somewhat greater then most aerolites, and it doubtless contains a little more iron than is usual in meteorites of its class.

THE DOÑA INEZ AND THE LLANO DEL INCA, TWO NEW METEORITES FROM ATACAMA, CHILI.

Prof. Ward obtained at Santiago de Chili, in April 1889, numerous small fragments of two siderolites, collected the previous year by the Chilian and Bolivian Boundary Survey.

The first of these was found near the Cerro de Doña Inez, and we therefore propose for it the name of *Doña Inez*. I am unable to state how much of this meteorite was found, but the amount secured by Prof. Ward was 16 lbs., the largest piece weighing 2 lbs. 10 oz. All of these fragments have a very peculiar cracked appearance, as if from shrinkage in drying, and look very much like lumps of dried redish grey mud with little spots of green mould (nickel) in places. They look as if they would crumble if roughly handled. On cutting them open, however, they are found to be firm and show no effect of decomposition below the surface.

The largest nodule of iron seen is about one quarter inch in diameter, which on being treated with dilute acid shows very fine Widmanstätten figures. Mr. J. M. Davison has kindly furnished me with the following analysis of this meteorite :

ANALYSIS OF THE DOÑA INEZ SIDEROLITE.

	Total mass.	29.77% total insol. in HCl.	70.23% total sol. in HCl.
SiO_2.	18.41	52.87	2.94
Fe O.	58.96	20.96	75.84
Al_2O_3.	6.39	7.52	5.89
P_2O_5.	.32	...	.46
NiO.	5.28	.72	7.33
CoO	.34	trace	.48
CaO.	3.56	1.67	4.42
MgO.	4.92	14.71	.53
S.	1.06	....	1.54
Cu.	trace	....	trace
	99.24	98.45	99.43
Less O. for S.	.53		.77
	98.71		98.66

Specific gravity 3.89.

The part insoluble in hydrochloric acid would appear to be enstatite with much of the magnesia replaced by iron, and to be the most abundant of the minerals present in the stony portion of the meteorite.

The conclusions drawn from the part soluble in hydrochloric acid (less the metallic portion) are less satisfactory, there being probably more than one mineral present. Anorthite is suggested as predominating.

JOHN M. DAVISON, Reynolds Laboratory,
June 30, 1890. University of Rochester.

The fragments of *the Llano del Inca* meteorite, of which Prof. Ward secured 27 lbs., were found in 1888, as already stated, 35 leagues S. E. of Taltal, Atacama, Chili, on the Llano del Inca. All the fragments are small, the largest weighing only 4½ ozs. They appear much more solid than those of the Doña Inez, none of them showing that cracked appearance or the "green mould." Sawed and polished sections of the two meteorites, however, are in many cases not distinguishable, but some fragments of the Llano del Inca contain very little iron, and considered by themselves would indicate another fall. One piece which we have polished seems, however, to unite the two extremes, one side containing a large amount of iron, while the other side, half an inch distant, contains only a few particles.

The following analysis of an apparently average specimen has been furnished through the kindness of Mr. L. G. Eakins, of the U. S. Geological Survey, and the courtesy of Prof. F. W. Clarke, chief chemist:

ANALYSIS OF THE LLANO DEL INCA.

Approximate composition of the mass.

	Metallic	25.8
	Troilite	10.6
Siliceous portion.	Sol. in HCl.	30.9
	Insol. in HCl.	32.6

Analysis of nickeliferous iron.

Fe.	89.77
Ni.	9.17
Co.	.61
	99.55

Analysis of siliceous portion from which all the metallic had been extracted.

	Soluble in Hydrochloric Acid.			Insoluble in Hydrochloric Acid.	
	1.	2.	3.	4.	5.
SiO_2.	11.53	11.53	28.08	23.15	53.11
Al_2O_3.	5.23	5.23	12.74	1.01	2.32
Cr_2O_3.	....	....	....	.39	.90
Fe O.	28 89	17.46	42.52	8.20	18.82
Ni O.	1.19	1 ·9	2.90	....	....
Mn O.	.08	.08	.20	....	....
Ca O.	3.83	3.83	9 33	.76	1.75
Mg O.	.81	.81	1.98	10.07	23.10
P_2O_5.	.93	.93	2.25	tr.	....
S.	5.08	....	....	....	....
	57.57	41.06	100.00	43.58	100.00
Less O. for S.	2.54				
	55.03				

The approximate composition of the mass was calculated from the weights found by extracting all the metallic portion with an electro-magnet, and the analysis of the residue, all the sulphur being calculated as troilite. Analyses Nos. 1, 2, 3, 4 and 5 were made on the silicate portion containing the troilite, from which the metallic part had been removed, and No. 1 is that of the actual portion soluble in hydrochloric acid. No. 2 is the same analysis from which all the sulphur and 8.89% of iron (equal to 11.43% Fe O) have been deducted. No. 3 is analysis No. 2 calculated to 100%. No. 4 is the analysis of the portion insoluble in hydrochloric acid. No. 5 is analysis No. 4 calculated to 100%.

L. G. EAKINS, U. S. Geological Survey.

June 30, 1890.

Although there is no striking resemblance between the analysis of the Doña Inez by Mr. Davison and the Llano del Inca by Mr. Eakins I am inclined to think they are parts of the same "fall." The difference in the analysis is not greater than might perhaps be expected from different parts of the same piece. A nodule of iron about one-quarter inch in diameter was found in one of the fragments of the Llano del Inca, which upon being etched shows markings apparently identical with those on the Doña Inez. The difference in the weathering of the pieces of the two may perhaps be accounted for by different conditions of exposure.

The breaking up of both meteorites, particularly the Llano del Inca into such small, solid, angular fragments with sharp corners, none of which show signs of a crust, can hardly be accounted for by decomposition, but is doubtless the work of man—probably mistaking the nickeliferous iron for silver, or curious to see what could be found. Perhaps the breaking up of the Llano del Inca is more recent than that of the Doña Inez.

The information at hand is not sufficiently definite to determine the distance between these two finds, but it is probably not more than 50 to 75 miles and possibly less.

Dr. M. E. Wadsworth, Director of the Michigan Mining School and State Geologist, has made an examination of these meteorites, and has furnished the following description :

MINERALOGICAL DESCRIPTION OF THE LLANO DEL INCA AND THE DONA INEZ METEORITES.

BY M. E. WADSWORTH.

Llano del Inca Meteorite.

Macroscopically this is a grayish brown rock composed of feldspar and other silicates with some iron, etc. On this specimen no sign of the usual crust of fusion could be seen such as is usual on meteoric stones. Except for the metallic iron, the stone closely resembles some terrestrial gabbros and diabases.

Microscopically the sections are seen to be composed of plagioclase, pyroxene, olivine, magnetite, iron, pyrrhotite (troilite) with various inclusions and alteration products. The general structure is granitoid like the gabbros and more coarsely crystalline diabases.

At my request a careful study of the minerals was made by Drs. A. C. Lane and H. B. Patton of the Michigan Geological Survey, and their results are given below.

Feldspar.—Plagioclase.

This is mostly in irregular grains which are but slightly idiomorphic. They tend to assume elongated lath-shaped forms that have the twinning stripes well developed, although rarely they are almost or entirely wanting. The twinning is usually in more than one direction. The plagioclase is taken by Dr. Lane for anorthite, who states that it shows the albite and pericline twinning with traces of the development of 010. The extinctions are often over 45°, being in the symetrical forms 54°–58° In one section no extinctions were observed indicating any feldspar more basic than labradorite. The cleavage planes run parallel and perpendicular to the twinning bands. In the plagioclase three kinds of inclusions occur which frequently render it cloudy.

1st. Very numerous grains, generally rounded or elongated, but sometimes very irregular in shape. They vary in size from 0.05 m. m. downwards, averaging about 0.01 m. m. As a rule the grains gradually diminish in size the farther they are from the edge of the feldspar. The index of refraction is high—the double refraction also being greater for the inclusions than for the inclosing plagioclase. The grains are colorless, varying to light brown in the larger forms. Sometimes they are arranged without apparent order in the feldspar, but generally they are in parallel lines, either parallel to the twinning planes or else lying in two directions oblique to each other, apparently parallel to the faces 010, and 001. These grains are considered to be augite.

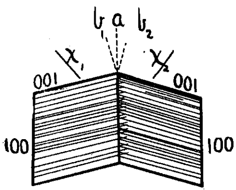
2nd. Very small inclusions, that are often so minute as to present a dust like appearance that are considered to be gas cavities.

3rd. Black opaque inclusions of probable magnetite. These are not abundant.

Pyroxene.

The pyroxene is considered by Dr. Patton and myself to be the diallage variety, but by Dr. Lane to be the augitic variety.

This mineral is abundant and shows a high index of refraction. It also has the high double refraction and oblique extinction of monoclinic pyroxene, with the fine striation of diallage. The color is light brown, but it has frequently been stained yellow. The pyroxene is almost uniaxial, $(+2V<10)$, and has a large dispersion $P<V$. The striation runs parallel to 001, and makes a small angle with the plane of extinction (0°. 13°, 16°. 14°. 12°. 15°). The striated sections give a disturbed axial image, apparently having one axis out of the line of sight. Pleochroism weak, yellowish parallel to the striation, pinkish perpendicular to it, while the greater refraction also lies in this last direction. The pyroxene shows both prismatic, and more rarely, pinacoidal cleavage. Rarely we have a combination of this basal striation (001), probably due to twinning, with the common twinning after the orthopinacoid (100). Then we have, if a is the trace of the twinning line, b^1, and b^2 the traces of the bases, x^1 and x^2 the extinctions corresponding to c :



$<a:b^1$	$<a:b^2$	$<a:x^1$	$<a:x^2$
+12°.6	−15°.1	+35°.4	−34°.1
20°.1	2°.	36°.	21°.4
20°.4		32°.6	0 3

While theoretically on 010 we should have:

+15° 49′	−15° 49′	+ab45°	−ab45°

The inclusions are mostly irregularly arranged particles of magnetite, and negative crystals (prisms and minute pinacoids), also gas cavities. Sometimes the inclusions are parallel and sometimes perpendicular to the striation, or again slightly oblique to it.

Enstatite.

One grain was observed by Dr. Lane which he thought might be enstatite, although it could be olivine. It is yellowish, dusty with inclusions, and the extinction parallel to the cleavage planes and inclosures.

Olivine.

This mineral is recognized by its white color, high refractive power, strong double refraction, and irregularly developed cleavage planes. It is quite abundant and is without crystalline form. Its cleavage cracks are often lined with yellowish oxides or iron. The inclusions appear to be magnetite.

Magnetite.

This occurs in irregular grains and is quite abundant. It also occurs as inclusions in the pyroxene and olivine as well as occasionally in the feldspar. It is easily distinguished by its dead black color in reflected light.

Pyrrhotite (Troilite).

This mineral is common in some sections and rare in others. It is distinguished by its brownish yellow color, which is darker than that of pyrite.

Iron.

This mineral is wanting in some sections, but it is abundant in others, making a fourth to a third of their mass. It is in irregular patches that are sometimes 1 to 2 m. m. long. It is recognized by its shining iron-grey color in reflected light.

Alteration Products.

All the minerals are more or less stained by a brownish to yellowish iron oxide; while the white inclusions in the feldspar may perhaps be an epidotic alteration of it.

Dona Inez Meteorite.

The hand specimen is a crystalline mass of brown color showing grains of olivine, iron, pyrrhotite, etc., inclosed in the groundmass.

This has weathered to a greater extent than the Llano del Inca, possibly due to its containing more iron.

Macroscopically its composition is the same as that of the Llano del Inca meteorite, but the structure is considerably different, the Llano form having its feldspar lying in a crystalline groundmass of the other ingredients, while in the Dona form the pyroxene and some of the feldspar are the porphyritic ingredients in a groundmass of finer and more rounded granules than that of the Llano form. Further the Dona form has been more altered than the other. The pyroxene constituent also differs considerably as determined below. It would from this be doubtful if the two specimens came from the same fall, although as great a variation might exist in two different parts of the same mass. The intergrowth of the pyroxene minerals gives a structure similar to some structures observed in the chondritic meteorites, and is apparently due to the same cause—crystallization. Both these meteorites are distinctly crystalline masses, and can in no sense be considered fragmental. In the Dona form besides the oxide of iron there are other alteration products resembling carbonates, delessite, hisingerite, feldspar, silica, etc.

Drs. Lane and Patton have reported, as before, on the special features of the minerals composing this meteorite, and the results of their work are given below :

Feldspar.—Plagioclase.

There is but little feldspar present, and in its general characters and inclusions it is like the Llano form. It is considered to be basic on account of its interference colors being as high as are those of the pyroxene. It shows the albite and more rarely the pericline twinning. Since the symetrical extinctions are positive and make an angle even greater than 45°, the feldspar is considered to be anorthite.

Pyroxene.

The pyroxene here is of two kinds—one a reddish monoclinic form having a strong double refraction, and the other a colorless rhombic form with a weak double refraction. The first form is diallage or augite, and the latter enstatite, with the extinction parallel to its cleavage planes.

The intergrowth of the two minerals is not in the usual longitudinal strips common in intergrowths of diallage and enstatite, but is very irregular and patchy, resembling the micropegmatitic or granophyre structure.

The enstatite cleavages are marked by cracks whose wall are stained with ferruginous material. One cross section was seen having a bisectrix and axial plane diagonal to the cleavage. $+2V$ is large.

Olivine.

This mineral is rare and occurs in irregular grains looking much like the enstatite, but shows much higher colors. Its cracks are stained with iron oxide. Optically it shows high refraction, with low double refraction and appears to have a large optical angle with a negative acute bisectrix.

Magnetite.

This is abundant in one section and surrounds the iron. It shows the usual characters of magnetite.

Pyrrhotite (Troilite).

This is opaque, bright and of a yellowish bronze color. Its form is irregular, and it is mixed with the magnetite.

Iron.

This mineral is abundant in one section, although less so than the magnetite. It shows the usual characters of the meteoric metallic iron.

Alteration Products.

A great amount of reddish and yellowish oxide of iron is present along the cleavage planes and cracks in the silicates. In one place there is an elongated body composed of iron oxide on the exterior, with a carbonate (?) interior and an intermediate portion of a greenish mineral having low interference colors. It appears to have too high an index of refraction for chlorite or for serpentine.

It will be seen (p. 97) that Dr. Wadsworth is inclined to regard these meteorites as distinct, and makes a strong point of the difference in structure and composition. When he will have had opportunity to examine the etched nodules of iron from the two meteorites, I think he will find it hard to believe that they come from distinct masses. The identity of structure in the iron nodules has more significance than the dissimilarity in the stony portions.

THE EL CHAÑARALINO METEORITE.

The beautiful siderite which is the subject of this notice, was found by Prof. Ward in the music store of Señor Kissinger, in Valparaiso, Chili, S. A., in May, 1889, where it had been deposited by the owner, Señor Lorenzo Sundt, who has since informed us that he purchased it in 1884 of a woman who kept a green grocery store at the port of Chañaral, Chili (latitude about 26° south). When first seen by him it was surrounded and partially covered with onions, and a spider had made its home in a specially deep pitting.

It had been brought in from near the mining camp of Merceditas, ten or twelve leagues to the east of Chañaral, by the woman's husband, a miner, who thought it must be silver.

EL CHAÑARALINO METEORITE.
(*One-fourth natural size.*)

The general form of the meteorite is, as shown in the illustration, unusually angular with no rounded corners. In addition to the usual pittings, which are well marked and characteristic on all sides, there are numerous small pittings, apparently of later formation, arranged in parallel rows about half an inch apart. These bear no relation to the other pittings, but are evidently referable to the structure, and although more numerous in some places than others are seen on all sides, and arranged in planes that cross those of the adjacent sides at right angles, approximately. Some of those on two sides may be seen in the illustration. This meteorite reached us in perfect condition and measured thirteen by nine inches (325x225 m. m.) and weighed ninety-four and one-half pounds, (43.4 kilos).

We have run a gang of six saws through it, cutting it into five sections and two end pieces, revealing several large nodules of troilite, directly in the center of some of which, and entirely surrounded by the troilite, are nodules of iron. An etched surface of one of these sections is suggestive of a scotch plaid, so broad and straight are the markings, two sets of which cross each other at nearly right angles, while a third set crosses one of these at an angle of 12° Some of the more prominent lines of kamesite are about half an inch apart, and suggest very strongly, both by their direction and spacing, a relationship to the lines of small pittings on the outside, previously referred to. There are, however, in addition to the large nodules of troilite mentioned, great numbers of specks of some sulphide, of a lighter greyer color than the large troilites. These specks must, I think, be considered the true cause of the lines of pittings, as it is possible in a few cases to connect the two at the edges of the sections. The specks do not, however, exhibit a like parallelism.

The amount of time and strength of acid required to bring out the markings on this iron is in marked contrast to the quickness with which dilute acid acts upon the Hamilton Co., Puquios and Welland meteorites. When this iron is analysed we will perhaps have a few more facts to offer.

THE LA PRIMITIVA METEORITE.

This small siderite, weighing only six or eight pounds, was given to the Superintendent of the Nitrate works at La Primitiva, Salitra, in 1888, by a native who found it near by. These works are situated in the desert of Tarapaca, 40 miles east of Iquique, Chili. When Prof. Ward visited this place in April, 1889, the Superintendent, Mr. J. F. Humberstone gave him a small piece weighing about an ounce, which is now in the Ward & Howell collection of meteorites.

THE CALDERILLA METEORITE.

A small piece of this iron was given to Prof. Ward by Señor Enrique Gigoux at Copiapo, in April, 1889. Señor Gigoux obtained it from a friend now dead. It is claimed that this small iron weighing only a few ounces was seen to fall at Calderilla, a suberb of Caldera, Chili, in 1883.

The Academy adjourned to the second Monday evening of October.

OCTOBER 13, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Fifteen persons present.

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

REV. JOHN WALTON presented the following

NOTE ON THE OCCURRENCE OF MESODON SAYII:

In July of 1890, at the Natural Science Camp on Canandaigua Lake, while conducting a class of young men in their search for Helices, I found two specimens of a very rare shell, namely *Mesodon Sayii*, Binn. I had not met with this species before, and in corresponding with my conchological friends in this locality in regard to it I learned they had never found it, nor had any of them a specimen of it in their cabinets.

This Helix was named *diodonta* by Mr. Say in 1824, and in 1840 this specific name was changed to that of *Sayii* by Mr. Binney, who describes it —

"Shell umbilicated, orbicularly depressed, thin, epidermis light "russet, shining; whorls between five and six, with numerous fine "oblique striæ; suture impressed, aperture lunately subcircular, not

Fig. 1.

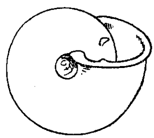


Fig. 2.

MESODON SAYII.

"dilated, peristome white, narrow, thickened, reflected, with a slightly "projecting tooth on the inner edge of the basal portion near the um- "bilicus; parietal wall with a sub-prominant, white tooth, umbilicus "open, deep, not wide, exhibiting all the volutions, slightly contracted "by the reflected peristome; base rounded, with striae distinct, con- "verging into the umbilicus. Shell about one inch wide."

"Animal light reddish brown, eye peduncles and tentacles smoky, "eyes black, head and neck cylindrical, foot narrow, terminating in an "acute point; length about twice the diameter of the shell."

The name *Sayii* has been very generally adopted by recent writers on the mollusca, in honor of the well known naturalist Thomas Say, a leading American conchologist of the last generation.

The allied species are *M. profunda*, *thyroides* and *albolabris*.

Why this Helix should be so scarce may perhaps be explained by the following incident:

"On the 3d day of July, 1836, Dr. Binney discovered an individ-"ual of this species in the act of laying its eggs in a damp place under "a log; he transferred them, with the animal, to a tin box filled with "wet moss. * * * They were white, adhering together very "slightly, flaccid, and apparently not entirely filled with fluid. During "the succeeding night the number had increased to about fifty, and in "a few hours they became full and distended. As the ***snail now began*** "***to devour the eggs***, he was obliged to remove it. On the 29th of July "all the eggs were hatched."

We hope during the present camping season to test the embryocidal propensities of *Mesodon Sayii*, and if able to do so, will report accordingly.

In March last while Mr. S. G. Crump and myself were shell hunting in a piece of woods at Pittsford, N. Y. he had the good fortune to find one specimen of this Helix alive, under a log. It was a great stimulus to us, and we searched diligently for hours, in the hope of finding more specimens, but in vain; although we gathered scores of the other allied species.

Since that time we have made several trips together to this and other localities, but have not yet succeeded in finding a second *Sayii*, although we have added to our collections several forms that we had not found previously in this neighborhood.

REV. C. B. GARDNER and the PRESIDENT described a day's excursion through the gas territory of Indiana, in August last, with the American Association for the Advancement of Science.

The PRESIDENT gave an account of the gas well in Stony-Brook-Glen, Steuben County.

PROF. A. L. AREY reported finding selenite at Jefferson Avenue Quarry; *Phacops trisulcatus* at Lower Falls; *Lichas Boltoni* at the Lower Falls, three feet below the graptolite layer; and at Lime Rock a *Dalmanites aspectans*, which measured 5⅛ x 3½ inches, an entire specimen of which had never before been found.

PROF. HENRY A. WARD mentioned a peculiar phenomenon observed by him at the Grotto del Cane, near Naples, Italy, in which the carbon di-oxide gas appeared, as one approached it from the path, like the surface of a mirror, or like a thin sheet of ice, the surface of the gas being on a level with the sill of the door.

The Secretary, PROF. AREY, suggested that this was a case of total refraction.

Mr. J. M. DAVISON exhibited a photograph of the coast at Kennebunk Beach, Me., showing stumps of large trees said to be the remains of a submerged forest. These stumps have every appearance of being in their original position. They are at the water edge at low tide, and buried to the depth of 5 or 6 feet at high tide.

He also exhibited a specimen of basalt from the same locality showing quartz pebbles included in the mass.

MR. E. E. HOWELL suggested in explanation that this rock was from an "intrusion," the conglomerate being carried up with the eruptive mass.

PRESIDENT FAIRCHILD called attention to a letter by Dr. M. A. Veeder, published in the New York Herald, in which he shows that a series of auroras may be traced backward through several years, recurring at intervals of twenty-seven days.

OCTOBER 27, 1890.

STATED MEETING.

Vice-President A. S. MANN, in the chair.

Forty-seven persons present.

The paper for the evening was read by MR. F. W. WARNER, on

PERU: ITS PEOPLE, PRODUCTIONS AND PHYSICAL CHARACTERISTICS.

The paper was illustrated by numerous photographs and specimens of pottery.

A vote of thanks was, on motion of Mr. Davison, extended to Mr. Warner by the Academy.

NOVEMBER 10, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Fifty-four persons present.

The Council recommended :

(1.) The election as active members of :

PROF. CHAS. W. DODGE,
MR. FRANK C. BAKER.

(2.) The election of MR. ROBERT BUNKER to life membership, in consideration of his gift to the Academy of his collection of insects.

(3.) The payment of certain bills.

The items of the report were separately adopted, the bills ordered paid, and the candidates elected by formal ballot.

The following candidates for fellowship, nominated May 12th, were elected Fellows by formal ballot :

MR. J. M. DAVISON,
MR. E. E. HOWELL,
MR. EMIL KUICHLING,
DR. FRANZ MUECKE.
MR. H. L. PRESTON,
MR. FRANK A. WARD,

A lecture was given by PROF. HENRY A. WARD, on

THE SPERM WHALE, AND OTHER CETACEANS.

Illustrated by charts and osteological material.

NOVEMBER 24, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Fifty-seven persons present.

MR. J. E. PUTNAM reported observing a peculiar form assumed by dust deposited on electric wires. The dust seemed to be attracted to the wires by the current of electricity. Wires with high tension currents become black much sooner than those with low tension. The deposits of dust were confined to the positive and negative wires. The soot had formed in one particular spot a little bunch of filagree work. Mr. Putnam also mentioned that the spiders did not build webs near the wires in the Edison Station. He thought that their absence was due to the singing noise produced by the brushes.

The President, PROF. H. L. FAIRCHILD, gave an illustrated lecture on

COAL; ITS ORIGIN, COMPOSITION AND STRATIGRAPHY.

Illustrated with specimens, diagrams and drawings of Carboniferous plants, and with lantern views of Pennsylvania coal-mining.

DECEMBER 8, 1890.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Twenty-two persons present.

The Council report recommended:

(1.) The election as active members of:

MISS ELIZABETH BOWLES,
MR. W. H. CALDWELL,
MR. BENJAMIN W. DODGE,
DR. CHARLES FORBES.
DR. GEORGE A. GOLER,
MR. ALVAH D. PRATT,
MR. WARD V. RANGER,
MR. E. H. SCRANTON,
MR. F. W. WARNER,

(2.) The payment of certain bills.

The bills were ordered paid and the candidates elected by formal ballot.

The following paper was read :

ROOT FOODS OF THE SENECA INDIANS.

By Geo. H. Harris.

A complete history of the foods of the aborigines of North America would fill volumes. The list comprises nearly all indigenous vegetation including grass, seeds, leaves, barks and roots ; all game animals, and many not usually eaten, as reptiles, insects and mollusks. We take into special consideration the root foods of the Seneca Indians who, but a century ago, possessed the magnificent domain their pale-faced successors denominate Western New York.

The Seneca was one of five separate nations that, about the middle of the fifteenth century, united in a confederacy termed by later white men the League of the Iroquois ; the territory of the confederated nations covering the present State of New York from the Hudson River to the Genesee, and by later conquest extending west and south of Lake Erie.

The mythology of the Iroquois assigns their creation to Hä-wen-né-yu, a Good Spirit who, with his brother Ha-ne-go-até-geh, an Evil minded spirit, once ruled the world. The Good Spirit created all useful animals and products of the earth ; while the Evil Spirit created all monsters, poisonous reptiles, and noxious plants. To assist them in their labors Hä-wen-né-yu and Ha-ne-go-até-geh created classes of subordinate spirits and committed to each the care of some particular thing. Every object in nature had its protecting spirit. Those spirits created by Ha-wen-né-yu were termed Ho-no-che-nó-keh, or the Invisible Aids. They were the guardians of fire, water, medicine, and all species of trees, shrubs, and plants, that bore good fruit or were beneficial to man. The spirits subordinate to Ha-ne-go-até-geh were, like their creator, antagonistic to all good things. They were the spirits of all plants and roots of a poisonous nature, the progenitors of witches and enchanters, and destroyed men with disease and pestilence.

Possessing a perfect knowledge of the topography of their vast territory, the Iroquois selected for their summer homes the open glades of the forest or the alluvial bottoms of the numerous valleys, where their crude efforts in cultivating the rich soils were repaid by abundant crops. When, in 1687 De Nonville, the French governor of Canada, came to Irondequoit bay and destroyed the Seneca towns, he was astounded at the immense supplies of food the Indians possessed. In his official account of the expedition De Nonville stated that the

French officers had the curiosity to estimate the whole quantity of ripe and green corn they had destroyed in the Seneca villages and fields, and they found the total amount 400,000 minots or 1,200,000 bushels. This was undoubtedly an exaggerated statement, yet it illustrated the fruitful returns of native industry, and the prosperous condition of those Indians who depended upon agriculture for their main support.

Ninety-two years later, during the revolutionary war, General Sullivan led an army of 4000 men to the Genesee river to chastise the Senecas for their destructive raids upon the border settlements of New York and Pennsylvania. The principal town of the western Senecas, then known as the "Genesee castle," was located upon the present site of Cuylerville, and consisted of 128 houses. On the rich soil of the valley near at hand the Senecas had 200 acres of grain, large crops of beans, potatoes and other vegetables, and several orchards, one of which contained 1,500 trees. The great Genesee valley was an ideal Indian paradise where all their simple wants were fully supplied; but Sullivan's soldiers destroyed everything of a nutritive nature, and at their departure did not leave in the locality food sufficient to save a child from starvation.

The deplorable circumstances of the Senecas, subsequent to these destructive invasions of the whites were fair examples of a condition to which these warlike people were constantly subject from enraged enemies. From riches and abundance they were liable at any moment to be reduced to poverty and starvation. In such emergencies their first recourse for food was wild game; and during the season of scarcity their rude implements of husbandry were often employed to delve in uncultivated plains and unfrequented nooks of the forest, for esculent roots upon which they subsisted for long periods.

We learn something of the domestic habits of the Iroquois from the narration of Luke Swetland, who was a prisoner among the Senecas at Kendaia, near Seneca Lake, from August 1778, to September 1779, and who, after his release, published an account of his adventures. Regarding their means of subsistence Mr. Swetland says: "The Indians live in some respects as one family, on corn, beans, squashes and potatoes while those last, some meat, sugar, milk and butter; but in the summer chiefly on ground nuts and other weeds and roots. Their country contains many lakes affording plenty of fish, salt springs where I made salt, a sort of root with which they make bread, they call it ook-te-haw, a great plenty of wild mandrakes, etc."[1]

1 Narrative of the captivity of Luke Swetland, among the Seneca Indians. 18.

Mr. Swetland gave little attention to the logical construction of sentences, and his statement "a sort of root from which they made bread, they call it ook-te-haw," leaves the reader—unversed in the Indian language—in doubt whether the term ook-te-haw applies to root or bread. In the Seneca dialect root is pronounced oke-tah′-a. Beets, carrots, parsnips, and turnips are all called roots and distinguished by their color, as oke-tah-a, root; oke-tah-dane-yo, roots; quin-tah-a, red; jit-quâ-a, yellow; no-wunt-dâ-a, white. In some cases the name of a root is circumstantial, and either describes the particular root or explains its quality and use. The Seneca word for bread is o-ak′-qua. It would thus appear that the term ook-te-haw, if the orthography is correct, did not apply to either word, root or bread, in its specific sense. According to the Seneca principle[2] of uniting nouns and adjectives to form new words, the compound term for bread-root would be oke-tah-ak′-qua; and it is clear that ook-te-haw was the proper name of a particular root then in such common use that a special description was deemed unnecessary; our inquiry therefore, properly includes the identity of this root.

In writing of the root ook-te-haw Mr. Swetland evidently had no reference to either the potato (*Solanum tuberosum*) or the ground nut (*Apios tuberosa*) as he in several instances distinctly mentions those articles of food by their common names; yet a partial history of these native plants is essential in our line of evidence.

Seneca tradition asserts that the Iroquois originally consisted of two tribes named after the bear and deer, each tribe using a picture or crude drawing of its appellative animal as a totem or clan mark. These tribes or clans increased in number and in the distribution of sachemships at the institution of the League, about the middle of the 15th century, eight distinct clans were recognized. The Paris Documents of 1666 contain an extended account of the Iroquois cantons at that date, and name nine tribes giving the title of the sixth as Sconeschèoronon or Potato people; the clan totem consisting of a string of potatoes. It is probable that this tribe was originally composed of captives whose special food consisted of potatoes, or whose particular business was the cultivation of that class of roots. Later designators of tribal names omit that of the Potato people, who had either received a new clan title, or been absorbed by other tribes.

An early historical mention of the potato is found in the journal of Thomas Herriot, who came to America in 1584 in the expedition of Sir Walter Raleigh. "Openawk," says Herriot, "are a kind of roots of round form, some of the bigness of walnuts, some far greater, which

2 Drop all letters following the inital consonant of the last syllable of the noun, and all letters following the first consonant of the adjective, then suffix the latter to the former.

are found in moist and marsh grounds, growing many together one by another in ropes, as though they were fastened with a string. Being boiled or sodden they are very good meat." The openawk was carried to England on the return voyage in 1586, and in 1597 Gerard figured the tuber in his Herbal under the name Potato of Virginia. From the date of their first settlement in America the colonists propagated the potato as a staple food, and at the middle of the 18th century it was considered a product of agriculture by the whites, who regarded the ground nut as a native or wild root. Contemporary tribes of red men also recognized the distinction between the potato and ground nut and gave a specific title to each plant. At the period of the revolutionary war the potato was cultivated by the Senecas who termed the tuber o-nun-un-da and planted it with their corn, beans and squashes. The modern Seneca term is o-no-nok′-dah ; and many of the present generation of Indians regard the potato and ground nut as one species and apply the same name to both.

In his Travels in North America, in 1749, Professor Kalm writes : "at the first arrival of the Swedes in this country, and long after, it was filled with Indians. * * The food of these Indians was very different from that of the inhabitants of other parts of the world. Wheat, rye, barley, oats, and rice groats, were quite unknown in America. * * The maize, some kinds of beans and melons, made almost the whole of the Indian agriculture. * * Hop-nis was the Indian name of a wild plant which they ate at that time. The Swedes now call it by that name and it still grows in the meadows. The roots resemble potatoes. They were boiled by the Indians, who ate them instead of bread. Some of the Swedes likewise ate them for want of bread. Some of the English still eat them instead of potatoes. * * Dr. Linneas calls the plant *Glycine apious*."

The narrative of the Gilbert Family captured in Pennsylvania and brought through the Genesee region in 1780, describes the arrival of the party in the vicinity of Canandaigua where "necessity induced two of the Indians to set off on horseback, into the Seneca country, in search of provisions. The prisoners, in the meantime, were ordered to dig up a root, something resembling potatoes, which the Indians called whop-pan-ies. They tarried at this place until towards evening of the succeeding day and made a soup of wild onions and turnip tops ; this they eat without bread or salt. * * They left this place and crossed the Genesee river * * They fixed their station near the Genesee banks and procured more of the wild potato roots before mentioned for their supper."

The name hop-nis, as rendered by Professor Kalm who obtained it from Indians on the Susquehanna river, and the term whop-pan-ies as used in the Gilbert narrative, differ in orthography, but the pronunciation of the two words is so nearly alike there can be no reasonable doubt of their identity. The modern Seneca for ground nut is yo-a-jah-go-o, which is interpreted, "being always in the ground."

An extended study of the subject impresses the writer with a belief that the bread root mentioned by Luke Swetland, can be identified as *Arum*[1] *triphyllum* of the botanist, commonly known as Indian

FLOWER AND FRUIT OF ARUM TRIPHYLLUM, AND O-A-O-SAH OR BABY-BOARD.

turnip, and variously termed three-leaved arum, wake robin, dragon root, pepper turnip, swamp turnip, starchworth, bog onion, priest's pintle, lord and ladies, jack in the pulpit, etc. This plant possesses every essential of nativity and quality requisite for a bread root, such as may have been used by the Indians during Swetland's enforced residence among them. It grows in damp woods, in swamps, in low

1. The name Arisæma is said to be a play upon the older name Arum. Torrey's Flora.

meadows, along ditches and in moist, shady places. It is well known to all lovers of wild plants as a floral curio, both on account of its peculiar flower and acrimonious nature. The root is roundish, flattened, an inch or two in diameter, covered with a brown, loose, wrinkled epidermis, and internally white, fleshy and solid. In its fresh state it is violently acrid, producing, when chewed, an insupportable burning and biting sensation in the mouth and throat, which continues for a long time, leaving an unpleasant soreness. It is used when fresh, and may be preserved a year by packing in damp sand. When dried and pulverized it produces a beautiful snow white powder, that when properly prepared, may be employed as a substitute for flour in making bread.

For many years the Senecas have called this plant "baby board," from its resemblance in form to the board used by Indian mothers as a convenience in the transportation of infants. The frame of a baby board is about two feet long, fourteen to sixteen inches wide, has a narrow shelf or foot-rest at the lower end and a hoop arched at right angles over the head. The infant is wrapped in a blanket and lashed to the board with broad belts. A small cloth is then drawn over the upper end and hoop, forming a hood that leaves the face of the child exposed yet secure from the weather. This board is termed o-a-o-sah. The peculiar shape of Arum triphyllum always attracts the attention of Indians who hold up their hands and say: "Just like baby board, that flower!"[1] hence they apply the name o-a-o-sah to the visible portion of the plant, but the part below the surface of the ground is known simply as oke-tah'-a, a root. It is probable that Swetland mis-pronounced the smooth flowing Seneca word o-a-o-sah, rendering it, in crude Yankee vernacular, ook-te-haw.

At the period of which Mr. Swetland wrote, the Senecas were associated with the British, in their efforts to subdue the American colonists, and received some aid from their English allies; but as a people they were mainly uncultivated nomads of the forest, characterized by the same habits and customs their ancestors had possessed for unknown centuries, dependent upon their skill as hunters and, to some extent, upon the natural productions of the soil. Our inquiry regarding the identity of ook-te-haw may, therefore, extend to the customs and diet of their forefathers as recorded in early chronicles.

In Thomas Herriot's account of Virginia in 1585, that writer informs us that "Cos-cus-haw * * groweth in very muddy pools and moist grounds. * * The juice is poison, and therefore heed must be taken before anything be made therewithal; either the roots must be first sliced

1 The writer gratefully acknowledges his obligations to J. H. Van Valkenburg, Superintendent of the Thomas Asylum at Cattaraugus, to Solomon O'Bail, A. Sim Logan and William P. Buck for interpretations of various Seneca terms.

and dried, and then being pounded into flour, will make good bread; or else while they are green they are to be pared, cut in pieces and stamped; loaves of the same to be laid near or over the fire until sour, and then being well pounded again, bread or spoon-meat, very good in taste and very wholesome, may be made thereof."

Captain John Smith's Virginia, 1606, says:—"The chief root they (the Indians) have for food is called loc-ka-whough. It grows in the marshes * * and is much of the greatness and taste of potatoes. * * Raw, it is no better than poison, and being roasted, except it be tender and the heat abated, mixed with sorrel or meal, it will prick and torment the throat extremely; yet in summer they use this ordinarily for bread." Carver's Travels in North America, 1766, says: "Wake Robin is an herb that grows in swampy lands, its root resembles a small turnip and, if tasted, will greatly inflame the tongue, and immediately convert it from its natural shape into a round hard substance; but when dried it looses its astringent quality and becomes beneficial to mankind."

"Taw-ho and taw-him," wrote Kalm, "is the Indian name of a plant the root of which they eat. * * Some call it tuc-kah. The roots are reckoned poison in a fresh state, * * but when prepared (by roasting) taste like potatoes. * * This taw-ho is the *Arum Virginicum*, or Virginian wake-robin, and seems to be the same plant the Indians in Carolina call tuc-ka-hoo. * * A stranger from Carolina gave Mr. John Bartram the following description of tuc-ka-hoo:—'It grows in swamps, marshes and woods, and the Indians in Carolina, in their rambles, gather the roots, dry them in the sunshine, grind and bake bread of them. While the root is fresh it is harsh and acrid, but being dried it loses its acrimony.' To judge by these qualities the tuc-ka-hoo may very likely be the *Arum Virginicum*. * * The Indians are very fond of turnips and call them sometimes hop-nis, sometimes kat-nis. * * Throughout the summer before the Swedes came, their hopnis or the roots of *Glycine apious*, their katnis or roots of *Sagittaria sagittifolia*, their tawho or roots of *Arum Virginicum*, their tawkee or *Orontium aquaticum*, and whortleberries, were their chief food."

The above accounts of the old writers are conclusive, that the aboriginal inhabitants of Virginia and Pennsylvania used *Arum Virginicum* as a material for bread. The variation of *A. Virginicum* and *A. triphyllum*, is so trifling that some authorities class them as one. The great aboriginal water communication between Lake Ontario and the Atlantic was through the Seneca country to the Susquehanna river;

thence, via Chesapeake bay to the Ocean, and it is well understood that the Indians of New York, Pennsylvania and Virginia were in constant intercourse (in fact the Iroquois claimed the country from Lake Ontario south to the Tennessee river), and that the customs and foods of the natives of those sections were in many respects the same. Swetland, unfortunately, gives no description of the root he calls ook-te-haw; but evidence in the hands of the writer shows that the pioneers of the Genesee Valley and County of Ontario, used the Indian turnip *Arum triphyllum* as a substitute for flour, and that they obtained their knowledge of the manner of preparing this root from Seneca Indians. It would seem that the cos-cus-haw of Herriot, the loc-ka-whough of Smith, the wake-robin of Carver, the tuc-ka-hoo of the South, the taw-ho of Kalm, the o-a-o-sah of the Senecas and the ook-te-haw of Swetland, were identical and that the bread root mentioned by Luke Swetland was *Arum triphyllum.*

Was it not a pressing necessity, that first induced aboriginal man to test the nutritious qualities of the most nauseous of all wild plants *Symplocarpus fœtidus*, commonly known as pole-cat root or skunk cabbage? The early Swedish settlers on the Susquehanna river called this plant, byron blad, or bear's leaf, and some termed it byron retter, or bear's root, from the fact that bears on leaving their winter habitations in the spring were excessively fond of it. The early Senecas called the plant o-sha-ta. They used the root for all purposes of food and medicine where arum could be employed. As a bread root it was roasted or baked to extract the juice, in much the same manner as arum. When the Seneca towns were destroyed by General Sullivan in 1779, the Indians found themselves utterly destitute and many moved to Fort Niagara where the British fed them, mainly on salt meats, during the following winter. As a result hundreds died of scurvy; but those who used the root of skunk cabbage as an anti-scorbutic, recovered their health.

That beautiful and curious plant, Solomon's seal, was also a welcome addition to the aboriginal larder in times of necessity. Many years ago a Seneca who was roving over the ground now named Highland Park, in this city, called the attention of his boy companion, the late John Nutt, to Solomon's seal as a plant once highly prized by Indians. He said it was formerly much used by the Senecas as a medicine, and that they also boiled the young shoots in the spring and ate them. The mature roots were gathered in the fall, dried, ground or pounded, and made into bread.

The method of manufacturing bread from roots was very simple. After the roots had been thoroughly dried and pulverized the flour was seasoned, mixed with a little animal or fish fat, moistened, worked into a pastry dough and patted into the form of a cake or loaf, which was placed on a piece of bark or flat stone turned up on its side close to the fire. Occasionally the stone was heated and the cake was thus at once baked on both sides. Sometimes the loaf was baked in a kettle or placed in the ashes under a cover of hot coals; and the individual who objected to eating the mass as it came from the fire with its covering of gritty ashes, was considered a person of poor taste and quite ill bred.

There is a question regarding the identification of an Indian bread root that is worthy the attention of the botanical section of this Academy. In narrating the privations suffered by the whites who settled on the Chenango river in 1788, Wilkinson's Annals of Binghampton says, that when their crops of corn failed and festive bruin had devastated their pig styes, the starving settlers went to an island in the river, and dug quantities of a tall weed termed Anicum, the roots of which they dried and ground or pounded into a coarse flour for bread-stuff.

It is possible that this so-called anicum was a species of the genus *Panicum* or panic grass, the seeds of which the wild Indians of the West still use for bread in the same manner white people use wheat; but the writer cannot learn that the seeds of anacum were utilized for food. Inquiries resulted in the description of a plant in many respects resembling *Psoralea esculenta*, commonly known in the western States as Indian bread root, prairie turnip, etc. Botanical authorities usually report *Psoralea esculenta* a native of the West and South; but a Seneca friend who had visited the Sioux Indians and was familiar with their bread root tip-si-u-nah, which plant possesses none of the poisonous qualities of arum, positively assured the writer that such a plant once grew in New York. A public agitation of the bread root topic last summer, was productive of the following letter from General J. S. Clark, the distinguished Indianologist and botanist, to Hon. George S. Conover of Geneva:

AUBURN, N. Y., July 11, 1890.

Dear Sir:—You are at liberty to state that *Psoralea esculenta* has been found in New York, in Washington county, many years ago by Mr. Frank R. Rathbun, of this city, and fully identified as the genuine plant growing in its wild state. A little more inquiry will probably establish the fact, that it has been discovered in other localities and may now be found in Central New York. I fully believe, however, that Luke Swetland's ook-te-haw is the well-known Indian turnip.

Very respectfully, JOHN S. CLARK.

In response to a request for particulars General Clark forwarded a letter from Mr. Rathbun from which we extract the following :— "The plant in question was found by myself, in the early summer of 1856 or 1857, at Fort Edward, Washington Co., N. Y., west of the Collegiate Institute, in a moist situation near the location, of the Jane McRea spring. As something unique, I carried the bulb, flower or seed vessel and leaves, to the Professor of Natural History at the Institute for analysis, before the class in botany. Pronounced by him a rare find, something new. I recollect he seemed surprised ; also recollect the specific term *esculenta* or Indian bread root applied to the specimen. His name was Solomon Sias. By the last Naturalists' Directory I find his address to be Schoharie, N. Y., (Solomon Sias, A. M., M. D.)"

It is well known that the flora of New York, has changed greatly during the past hundred years, and it may be an interesting question for our botanical section to decide, whether *Psoralea esculenta* can be added to the list of extinct plants.

The yellow pond lily, now so greatly admired as an aquatic flower, is a native of marshes, and the Senecas who frequented Irondequoit bay often procured the roots from the marsh-beds that surrounded that beautiful and historic sheet of water. The roots are large, sweet, and glutinous and not an unpleasant food when boiled or roasted and eaten with wild fowl or meat ; or if well seasoned with salt. The lily was known to the early Senecas as o-was-oos-hah, a word almost identical in sound with the native name (o-a-o-sah) of arum or baby board ; but the writer has been unable to learn the meaning of the term as applied to this particular flower.

Musk rats, which once abounded in all the shallow waters of the Genesee country, stored quantities of the lily roots in their rude houses for winter support ; and it was the usual custom of the Indians when hunting the little water animals, to search their houses for the roots. It is a fact, well attested by men who have been familiarly associated with Indians and accustomed to their food, that when properly dressed to remove the rank odor, the flesh of the musk rat is excellent meat ; and the Senecas doubtless had good reasons for heartily enjoying their winter dishes of ju-no-dâ-gâ, or musk rat flesh, and o-was-oos-hah, or pond lily root.

A more extended list of root foods might be presented, but a sufficient number has already been described. The hungry aborigines satisfied the cravings of appetite with all manner of vegetation not absolutely poisonous, and rendered edible many plants and roots of a known poisonous nature, by maceration in cold and hot water, and by baking and frying ; thus evaporating the deadly juices and nullifying the unpalatable characteristics. Vegetable matter reduced by such means is usually insipid, and the Indians often resorted to various expedients for seasoning. Salt was the principal and natural recourse. There were sev-several saline springs in the territory of the Sencas besides those east of Seneca lake mentioned by Luke Swetland. The Indians of the Genesee Valley often came to Irondequoit bay to make salt. There was a salt spring at the head of the bay on the west side, one in Dunbar hollow, and others east of the bay. The last one used by the Senecas was located in Webster, south of Forest Lawn. When the Senecas retired to reservations about 1796, an old chief from Moscow, in company with Jacob Walker the tory first-resident of Irondequoit, covered the Webster spring with stone, so effectually concealing it that it remains undiscovered to this day.

As substitutes for salt the Indians used the white portion of hard wood ashes, the ashes of corn cobs and certain leaves, and occasionally the lye of wood ashes. Fish, animal fat, and oils produced from nuts were also employed to modify the unpleasant qualities of root foods. The meats of nuts were often mashed into a sort of butter-grease for seasoning. Butternuts especially were reduced to a thin milk that was considered nourishing for infants and children. Other vegetable matter, such as acorns and dandelion roots, was roasted, pounded and sprinkled over the cooked roots. Squash rinds, corn meal and maple sugar were dainties. Horse-radish was boiled with meats as well as roots, and mints and cress proved acceptable relishes.

Acids were supplied by wild fruits and berries when those could be obtained. A loaf of root bread well sprinkled with berries was not to be sneezed at. The sumach also provided an agreeable wholesome acid. It was called ote-kó-dâ, by the Senecas who were careful to select the red-berried sumach, as the white-berried species is poisonous It was a happy day when the hungry root-eater discovered a nest of black ants. The insects were called je-hus-to-qua. The Indians laid upon the nests pieces of freshly peeled bark upon which the ants gathered in large numbers and were at once secured. The sharp vinegar-like taste of the insects was a great incentive to appetite.

The kâ-no was, or cow-slip, the o-nah-sâ, or mushroon, the o-nus-tâ-sah, or sassafras, the green shoots of o-nó-to-wâ-nes, or the burdock, the ya-ho, or mandrake, the jes-tâ-ga-â-go-wâ, or wintergreen, the leaves of the birch, beech, willow, basswood and gooseberry, the ground seeds of â-wâs-â-sâ, or the sunflower, were all utilized as relishes, and in extreme cases as substitutes for solid foods.

Among the various nations of Indians that now roam the plains and forests of the West, with the unrestrained freedom of ancient nomadic life, the old time habits and customs still prevail, and whole tribes eke out a precarious existence upon vegetable diets consisting mainly of esculent roots; but the reservation Indians of the State of New York have long been dependent for subsistence upon the products of intelligent agriculture, and even the legendary knowledge of ancestral foods has in many instances utterly faded from remembrance. Occasionally an educated Indian will cast a gleam of light upon the dark kitchen mysteries of his progenitors, and now and then the student of aboriginal history discovers a diamond of knowledge in the crooning of some aged Seneca who cherishes a memory of the strange habits and stranger tastes of his wild-wood forefathers.

DECEMBER 22, 1890.

STATED MEETING.

The President PROF. H. L. FAIRCHILD, in the chair.

Twenty persons present.

The accessions to the Library were noted.

The paper for the evening was read by MR. H. L. PRESTON, on

QUARTZ; THE PROTEAN MINERAL.

Illustrated by a large collection of various forms of the mineral.

JANUARY 12, 1891.

TWELFTH ANNUAL MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Seventeen persons present.

The Annual Reports of the officers and sections were presented.

SECRETARY'S REPORT.

The report of the Secretary, PROF. A. L. AREY, is summarized as follows:

Eighteen meetings were held during the year, the average attendance being fifty persons. All the meetings have been held in the University of Rochester. The suspension during the winter of street cars was the cause of the small attendance at several meetings.

Twenty-three active members have been elected, and six members have been made fellows.

During the year eighteen papers have been read, divided among the following subjects: Archaeology, Astronomy, Physics, Engineering, Geography, Mineralogy, Physiology, one each; Biology, Botany, Geology, Zoology, two each; Meteorology, three.

The Council has held its regular meetings.

CORRESPONDING SECRETARY'S REPORT.

MR. GEORGE W. RAFTER, the Corresponding Secretary, transmitted a report, in abstract, as follows:

A number of Honorary and Corresponding Members were elected at the meeting of May 12, 1890, and each person so elected notified by formal letter. With one exception all have signified acceptance, and generally in terms exceedingly complimentary to the Academy.

Correspondence has also been held with some of the Honorary and Corresponding Members in reference to the presentation of papers during the year 1891, and it is expected that such will soon be received.

The initial publication of the society has been sent to all Honorary and Corresponding Members and to one hundred and thirty societies, journals, institutions and government bureaus in the United States and the Dominion of Canada.

Two hundred and ninety-three copies of the publication have also been forwarded to the Bureau of International Exchanges of the Smithsonian Institution for distribution in foreign countries. Each copy, both to home societies and to foreign, is accompanied by a circular letter asking that the receipient of the same exchange publications with the Academy.

Acknowledgements of receipt have been received from nearly one hundred of the addresses in the United States and Canada; and exchange publications have also come to hand from a considerable number. Others to whom the Academy publication was forwarded have promised exchanges at an early date, and we may confidently expect a considerable addition to the library from this source.

Relative to the foreign exchanges it may be stated that it is too early to receive returns from them.

All exchanges received to date have been acknowledged, and deposited at the Library, at the disposal of the Librarian.

LIBRARIAN'S REPORT.

The Librarian, MISS MARY E. MACAULEY, transmitted a report on the condition of the library, from which the following is extracted: "The small size of the library is due * * to the fact that until the last year the Academy published none of its proceedings for exchange, the few papers printed being mainly for local distribution. During the past few months the accessions have become sufficiently numerous to warrant the belief that the Academy will soon possess a creditable and valuable library."

TREASURER'S REPORT.

The Treasurer, Mr E. E. HOWELL, made a report of the year's finances of which the following is a summary:

Receipts.

From former Treasurer	$ 96.36	
From initation fees and annual dues	438.00	
From interest	5.76	
Total		$540.12

Expenditures.

Notice of meetings, stationary, postage, janitor, etc.,	$122.97	
Printing Proceedings (Brouchre I)	233.30	
Illustrating " " "	110.00	
Total		$466.29
Balance in treasury		$73.85

REPORT OF THE SECTION OF BOTANY.

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

The officers of the Botanical section are: Miss M. E. Macauley, Chairman; Miss Florence Beckwith, Vice-Chairman; Mrs. J. H. McGuire, Recorder.

The Section has met regularly each alternate Friday evening, and has held 25 meetings during the year.

The practical studies from Bessey's Botany with the microscope, have been conducted as far as possible in accordance with the author's plan, and have been eminently successful.

In the studies of plant tissue, when growing specimens could not be obtained, prepared slides from Mr. Streeter's extensive collection have been used.

Plants indigenous to this vicinity have been examined in their season, and their habits and variations noted.

Extracts from the Minutes of the Section.

January 24, 1890. Microscopical studies. Parenchyma tissue of Castor-oil Bean. Bast tissue of *Abutilon.* Rind of Orange showing oil vessels. Bark of Cinnamon. Spore fruit of *Chara fragilis. Protococcus.*

February 21, 1890. Microscopical studies:

Mr. Walker showed pollen grains of *Symplocarpus fœtidus.*

Mr. Dumond showed a specimen of *Vaucheria sessilis*, with zoospores in process of formation.

Mr. Dumond exhibited specimens of the Scotch Heather and Holly ; also Lichens and Mosses which he brought from Scotland.

April 18, 1890. Miss Macauley exhibited a *Sanguinaria Canadensis* having pink blossoms, found at Fairport ; also *Dicentra Canadensis* and *D. cucullaria* which were found growing together in great abundance.

Miss Beckwith showed *Pellæa atropurpurea* from Wisconsin.

The microscopical studies were spore-sacs of *Peziza coccinea* in various stages of development, also a number of Desmids.

May 16, 1890. The plants examined were *Smilacina stellata, Pedicularis Canadensis, Geranium maculatum, Ranunculus repens, Viola cucullata, Anemonella thalictroides, Saxifraga Virginiensis, Sambucus pubens, Caltha palustris, Ribes floridum* and *Mitella diphylla.*

Mr. Dumond exhibited the spores of *Equisetum arvense*, showing the movements of the elators.

May 30, 1890. The evening was chiefly devoted to an examination of the phanerogams.

The microscopical studies were, *Protococcus* shown in the motile stage, and the red form in the resting stage.

June 13, 1890. *Lithospermum hirtum* was shown by Miss Macauley. The habitat of this plant, as given by botanists, is decidedly west and south of this locality. It is possible this specimen may have been an escape, as it was found near the roadside. Miss Macauley also showed the *Veronica Buxbaumii*, which is rare.

July 4, 1890. The Section made an excursion to Bergen swamp. The following account is quoted from Miss Macauley's report:

"The *Mitchella repens* covered the ground, in many places forming a dense carpet. Both the long and short styled flowers were found. The *Linnæa borœalis* was nearly out of bloom. Although many blossoms were seen they dropped as soon as picked. The *Cornus Canadensis*, too, was just about gone, only a few blossoms being gathered. The ferns were many and beautiful, *Cystopteris bulbifera* growing in some places in graceful luxuriance. The *Aspidiums* were not in fruit. *Osmunda cinnamomea* was very abundant. *Botrychium Virginicum* was found with unripe spores. *Lilium superbum* was also found. Among orchids were found the *Calapogon pulchellum*, *Habenaria viridis*, *Habenaria dilatata*, *Cypripedium spectabile*, *Pogonia ophioglossoides*. The *Sarracenia purpurea* was found, but the petals had fallen. The *Drosera rotundifolia* was found in blossom, also the *Monotropa uniflora*. Growing along with *Mitella diphylla* was found the *Mitella nuda*, which is very scarce. In some places the *Coptis trifolia*, or Gold-thread was seen in abundance. The *Taxus Canadensis* was found in fruit."

Although too late in the season for many of the plants common to Bergen, to be in flower, Miss Macauley's list shows the rich flora of that favored locality.

August 1, 1890. Among the many plants examined were *Asclepias tuberosa*, *Cornus stolonifera*, *Lysimachia ciliata*, *L. quadrifolia*, *Galium triflorum*, *Desmodium acuminatum*, *D. nudiflorum*, *Lobelia inflata*, *Stachys palustris*, *Solidago arguta*, *Scutellaria galericulata*, *Epilobium angustifolium*, *Verbena hastata*, *V. urticifolia*, *Adiantum pedatum*, *Apocynum androsaemifolium*, *Pontederia cordata*, *Helianthus divaricatus*, *Utricularia vulgaris*.

The pollen of *Ceratophyllum demersum*, rarely found in fruit, was examined with the microscope.

August 15, 1890. *Sagittaria variabilis* var. *obtusa, and S. variabilis* var. *hastata* were shown and the staminate and pistillate flowers noted.

August 29, 1890. Miss Beckwith called the attention of the Section to a curious differentiation in the size and division of the leaves of *Taraxacum officinale*. In four different plants which she exhibited, each had leaves peculiar to itself. These variations are not mentioned in either Gray's or Wood's Botanies.

In microscopical studies the sieve tissue of the stem of the Pumpkin vine was shown. Also the fruit of *Adiantum pedatum.*

Mr. Dumond exhibited the *Pandorina morum* with escaping cells and resting spores.

August 29, 1890. The microscopical studies were the terminal bud of Ash, the laticiferous tissue of Salsify, sections of Corn-stalk, and *Gymnogramme triangularis* and fruit.

Mrs. Streeter read an article on the Movements of Diatoms.

Mr. Bacon read an account of artificial germination of milk-weed pollen. Two pressed specimens of *Goodyera pubescens* were shown; also *Blitum capitatum.*

September 26, 1890. The seeds of *Pentherum sedoides* were examined and found to be beautifully marked; the attaching stalks were a bright scarlet.

Three varieties of Aster were shown, *A. Novæ-Angliæ*, *A. miser*, *A. puniceus*. *Gentiana Andrewsii* and a fine specimen of *Marchantia polymorpha*, showing gemmæ cups were also exhibited.

October 24, 1890. Miss Beckwith showed two beautiful Southern plants, *Cosmos bipinnatus* and *Euphorbia heterophylla*. The former had rose-colored rays and finely divided leaves; the latter had a strip of scarlet in the upper bracts. A section of the stem showed the latex vessels.

A number of species of Fungi were examined. Among them were several specimens of *Polypori*, one *Ciavaria*, *Agaricum velutipes, A. laccatus; Marasmius rotula*, and a Peziza of a pale gray color.

The *Azolla Caroliniana* was shown and the formation of the spores explained.

November 7, 1890. Mr. Streeter showed the abscissa cells in the petiole of the leaf of Horse-chestnut, also the seeds of Beech-drops.

Agaricus fabaceus and *A. illicitus* were shown. An article on Cacti was read.

One of the most interesting objects, and one never before seen in the section, was the *Lunularia vulgaris*, one of the Hepaticæ, shown by Miss Beckwith. The gemmæ were well defined.

November 21, 1890. Miss Macauley showed a number of Fungi and Lichens.

A section of gill, showing the spore-bearing cells, was examined with the microscope.

The Chairman showed the following plants in blossom: Golden-rod, Mallow, Sonchus, Capsella, Clover, Carrot, Buttercup, Dandelion and Hedge Mustard.

December 19, 1890. Mr. Streeter showed the sieve tissue of *Cucurbita pepo* and also of Bryony ; prepared slides of annular, spiral, and reticulated vessels ; Glœocapsa, showing cell division ; Spirogyra in conjugation ; Starch grains ; Crystals from Onion ; Aleurone from *Ricinus communis* and raphides.

The circulation of protoplasm in *Vallisneria spiralis* was shown by Mr. Dumond.

January 2, 1891. Mr. Streeter exhibited a number of pressed flowers from Alaska. Among them were species of Anemone, Strawberry, Clematis, Geum and Larkspur. There was also a plant similar to our Dwarf Cornus.

Miss Beckwith showed a *Shepherdia argentea* from Big Horn City, Wyoming. She also reported finding in blossom at this date Dandelion, *Capsella*, Chickweed, and *Senecio vulgaris*.

The microscopical studies were leaf of *Narcissus*, scale and bud of *Shepherdia*, growing point of Indian Corn and a section of squash showing spiral and ringed vessels.

REPORT OF THE SECTION OF GEOLOGY.

(*In abstract.*)

Read by H. L. Preston, Recorder of the Section.

During the past year the Geological Section has held sixteen meetings, with an average attendance of ten persons, the smallest number present at any meeting being seven, the largest seventeen.

The plan of work and the character of the meetings have been the same as last year. The meetings were held on Tuesday evenings, twice a month, in the Section Room of the Academy, on the second floor of Anderson Hall, University of Rochester.

The Section has received during the year eleven new members, making a total of twenty seven names now on the roll.

Extracts from the Minutes of the Section.

Jan. 20, 1890. Mr. Walker presented to the Section a fine specimen of Labradorite taken from a large boulder near No. 19 School building. Mr. H. L. Preston read a paper upon agates and waterstones from Uruguay.

The topic of the evening was, The Chemical Agencies of Water. Mr. E. E. Howell spoke of the necessity of keeping the native iron from Greenland exposed to the open air, in order to keep it from disintegrating, and cited other illustrations of this unusual fact. The topic was further discussed by various members of the Section.

Feb. 3, 1890. Various specimens were exhibited by the members. The topic, Internal Heat of the Earth, and Earthquakes, was discussed by the Section.

Prof. H. L. Fairchild exhibited, in illustration of this topic, large volcanic bombs from Auvergne, France, and various forms of lava from other localities, especially from the Sandwich Islands. Also a series of lantern slides illustrating volcanic phenomena.

Feb. 17, 1890. Mr. E. E. Howell exhibited a portion of a new iron meteorite, recently added to the Ward and Howell collection, from Welland, Can., which was found April 30, 1888. Mr. Walker presented a glaciated rock, obtained on a new street in the western part of the city. Mr. J. M. Davison described glacial markings at Saratoga, also others found beneath the Detroit river, Mich.

Mr. Howell described glacial furrows two feet wide and one foot in depth near Dunville, on the north shore of Lake Ontario; also furrows of a size sufficient to receive a cane, which made a complete turn in direction, a phenomenon he had noticed only at one other locality, St. Catharines, Canada.

The topic for the evening, Geysers, was illustrated by specimens from the Yellowstone Park, and from Iceland.

Various specimens were presented for identification.

March 3, 1890. The topic for the evening being Earthquakes, Mr. Howell, the Chairman, exhibited a model and diagram of the earthquake at Tokio, Japan. Jan. 15, 1887.

Professor Fairchild exhibited U. S. weather maps, and described the system of publishing weather observations.

March 17, 1890. The by-laws were changed, making the meetings occur on Tuesday evenings following the first and third Mondays in each month.

The topic for the evening was Organic Agencies, and the formation of Coal. Professor Fairchild exhibited a quantity of material illustrating the subject, and described a peculiar deposit of peat, found in the city of Scranton, which showed the formation from peat, of the coal-like mineral known as dopplerite. Mr. Crump presented for identification a coal fossil, probably a cast of the pith of some coal plant. Other material was presented for identification by different members of the Section

April 1, 1890. The topic for the evening was Petroleum, Coal, Graphite, Etc. Various specimens were brought in for identification.

April 22, 1890. Mr. Preston exhibited the largest gold nugget ever found in South Africa.

The topic was, The Formation of Coral Reefs. Mr. S. G. Crump discussed the topic, and gave several theories of the formation of coral reefs. Professor Fairchild illustrated the subject with lantern views. Various minerals were presented by Mr. Walker and Miss Beckwith for identification.

May 6, 1890. Various fossils from the phosphate bed of Charleston were exhibited.

The Chairman of the Section, Mr. Howell, described an interesting example of jointing in gneiss on the Potomac River, which in form resembled the basaltic columns in the Rhine Valley.

The topic of the evening was Geographic Distribution of Animals. Miss A. M. King and Mr. Walker presented various minerals for identification.

May 20, 1890. Professor A. L. Arey exhibited a specimen of micaceous hematite, also Mexican onyx.

Mr. Howell, the Chairman, exhibited several aerolites that fell May 2, 1890, near Forest City, Iowa. He also spoke of the recent discovery of some twenty pieces of meteorites in Kiowa County, Kansas. He also exhibited a polished and etched slice of the Puquios, Chili, meteorite, which showed a definite fault-plane running through its mass; this being the first fault recorded as occuring in iron meteorites.

The difficulty of working and cutting meteoric iron was commented on by the Chairman.

The topic of the meeting was, The General Formation and Structure of the Earth.

June 3, 1890. Mr. Walker presented to the Section a nearly complete specimen of the *Halysites catenulates*, which he obtained at a limestone quarry on Brown Ave.

Specimens of rock were exhibited by Mr. Howell and Professor Fairchild, which had been obtained at Stony-brook Glen, Steuben Co., on the occasion of the geological excursion of the Academy, May 30th. These rocks were calcerous and contained large rounded masses that were either boulders or concretions.

Mr. Howell also described a fault which he had observed in Stony-brook Glen, in which the overhanging wall had risen, an illustration of the abnormal form.

Mr. J. M. Davison described a phenomenon at Saratoga, where the Trenton limestone was so mixed with fragments of the underlying calciferous sandrock as to give it the appearance of a breccia.

Oct. 21, 1890. The evening was mostly spent in discussion as to whether the specimens of rock from Stony-brook Glen, exhibited at the Section, June 3d, were boulders or concretions, but without arriving at definite conclusions.

Professor Fairchild exhibited two forms of clinomoter, and explained their use.

Mr. Preston exhibited a specimen of *Dalmanites aspectens*, the property of Professor Arey, found at LeRoy, N. Y., which was the only complete specimen of this trilobite known, although heads and tails of this species have been found separately in abundance.

Various specimens were presented for identification.

Nov. 4, 1890. The topic for the evening was Cleavage. Professor Fairchild exhibited several specimens, illustrating different kinds of cleavage.

Nov. 18, 1890. The officers of the Section for the ensuing year were elected as follows: Chairman, Mr. E. E. Howell; Vice-Chairman, Mr. S. G. Crump; Secretary, Mr. H. L. Preston; Sectional Committee, Mr. J. M. Davison and Rev. John Walton.

Dr. Franz Muecke exhibited a specimen of bog iron ore and manganese from Brighton, near Rochester. Also an incrustation of leaves and twigs from the travertine bed, of Mumford, N. Y. Mr. W. W. Gilbert exhibited a specimen of silicified wood from the drift in the Genesee Ravine; also zelenite from Frost Avenue.

Professor Fairchild described the mineralogical character of the Niagara limestone in Pike's quarry on Frost Avenue.

Mr. Worthington exhibited fossil coral from England.

The topic for the evening, Concretionary Structure, was discussed by various members, and Professor Fairchild exhibited numerous specimens illustrating various forms of concretionary structure.

Mr. Walton exhibited a fine concretion, showing a fossil as a nucleus.

Mr. Davison showed a thin section of silicified oolite, from Center county, Pa.

A committee, consisting of Professor Fairchild and Mr. Howell, to whom was referred the Stony-brook Glen specimens, reported their inability to arrive at a unanimous conclusion.

Dec. 2, 1890. Mr. Davison exhibited a specimen of silicified shell, from near the lower falls of the Genesee.

Mr. A. S. Mann exhibited alumn from Greigsville, N. Y.

Professor Fairchild and Mr. Howell were appointed a special committee to obtain samples representing the strata penetrated in drilling for natural gas on the premises of Otis and Gorsline on Oak street.

The topic for the evening was Fossilization.

Dec. 16, 1890. Professor Fairchild reported that arrangements had been made to secure borings from the gas well of Otis & Gorsline.

Mr. Preston, the Recorder, was instructed to secure a case in which to deposit the collection of local fossils presented to the Academy by Prof. A. L. Arey.

The topic for the evening was Sedimentary Rocks.

Jan. 6, 1891. Mr. Muecke exhibited a specimen, thought by him to be the fossil of some gasterpod shell, and which he obtained in a quarry on Goodman street. Silicified shells were exhibited by Miss King.

The topic for the evening was Igneous Rocks. Mr. J. M. Davison exhibited and described several microscopic sections of igneous rocks, which showed the crystaline structure of such rocks, and the development of crystalline forms in rock masses.

REPORT OF THE SECTION OF ZOOLOGY.

The preliminary steps for the organization of this Section were taken after the regular meeting of the Academy of March 10, 1890, at which time a meeting for temporary organizations was held, and a committee consisting of Prof. H. L. Fairchild, Dr. J. Edw. Line, and Dr. J. L. Roseboom appointed to draft rules, and suggest an organization. This committee reported to the Section, April 14, 1890, the organization suggested by them being adopted, namely, for Chairman, Frank A. Ward, for Recorder, Geo. W. Rafter. The rules adopted were similar to those of the Geological Section.

The first regular meeting for the discussion of scientific subjects was held April 30, 1890, at which time Prof. H. L. Fairchild presented to the Section a letter from Mr. G. W. Hill, of Fisher's Station, in reference to a number of weasels attacking a man. According to Mr.

Hill's account, John Briggen, a tenant of his, while waiting for his horse to drink at a small stream, saw on the opposite side about twenty-five to thirty little red animals of different sizes. This army of weasels as it turned out to be, advanced across the stream and climbed up the legs of both man and horse. They were only driven off by considerable effort on the part of the man and by the assistance of his dog coming to the rescue. Mr. Hill concludes that these weasels were probably traveling, and states that he on a previous occasion saw as many as fifteen together, and last summer he also killed a large one that had chased and frightened a little boy. Mr. Geo. H. Harris is also cited as having been once attacked by a weasel.

In discussion of Mr. Hill's letter Prof. Henry A. Ward related a number of cases of other animals, which occasionally travel in large numbers and which are at such times very aggressive.

At the meeting of May 14, 1890, the scientific topic of the evening was on *Chlamyphorus* by Mr. Chas. H. Ward, who gave an account of the classification and place of the Chlamyphori, and explained in detail the structure of these animals. Mr. Ward exhibited several mounted specimens of the Armadillos. Among them a fine specimen of the Peba, the only Armadillo found in the United States.

Mounted specimens of Sloths were also exhibited, as for instance the *Chevelepus Hoffmani*, distinguished by wearing a covering of green Algæ when found. It was stated by Prof Henry A. Ward that nearly all the Sloths carried similar parasitic growths of Algæ.

Pulmonary Gastropods were the subject for discussion at the meeting of May 28, 1890, presented by Mr. S. G. Crump, who discussed the subject with reference to a collection from the Philippine Islands. Prof. Henry A. Ward also exhibited and described a collection of snails from Lake Tanganyika.

At the meeting of June 11, 1890, Prof. Henry A. Ward took as a topic the sperm whale, and discussed it in all its phases, with a large amount of illustrative material.

No further meetings were held until Oct. 13, 1890, at which time Mr. Geo. W. Rafter, discussed the Entomostraca of the vicinity of Rochester, exhibiting a number of photomicrographs of the same, and mounted objects under the microscope.

At the meeting of Dec. 10, 1890, Mr. Frank C. Baker discussed the Digestive System of the Mollusca, illustrating the topic by charts, microscopic mounts and a collection of shells.

The foregoing comprises the more important work of the Section during the year. Although a numbei of other topics have at different times been up for discussion. An exceeding pleasant feature of these meetings has been the presence of Prof. Henry A. Ward, and the interest in the work of the Section has been largely due to his extensive fund of information on all the subjects discussed.

ELECTION OF OFFICERS.

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

President, H. L. FAIRCHILD.
First Vice-President, A. L. AREY.
Second Vice-President, J. EUGENE WHITNEY.
Secretary, FRANK C. BAKER.
Corresponding Secretary, GEO. W. RAFTER,
Treasurer, EDWIN E. HOWELL.
Librarian, MARY E. MACAULEY.
Councillors,
For three years, { FLORENCE BECKWITH. J. L. ROSEBOOM.
To fill vacancy,—H. L. PRESTON.

The following paper was read :

DESCRIPTIONS OF NEW SPECIES OF MURICIDÆ, WITH REMARKS ON THE APICES OF CERTAIN FORMS.

BY FRANK C. BAKER.

Several months ago I gave the results of my investigation upon the apex in the typical or *Tribulus* group of Murices.* In that paper I described the apex of thirteen species. In the present communication I shall add five species to that number.

The embryonic apex of the typical group appears to be divisible into two principal groups or divisions ; first, those with smooth, rounded whorls, and second, those with carinated whorls.

The smooth rounded whorls appear to be but little diversified, whilst those of the carinated group are subject to no little variation. The carina, for example, may end either in the suture below, or be merged with the lowest of the four spiral liræ of the succeeding whorls. The embryonic varix is not always present, and the carina, not infrequently, ends abruptly in the center of the last embryonic whorl. The number of whorls seems to be quite constant, two, to two and a half

* (Proc. Acad. Nat. Sci. Phil., 1890, p. 66.)

being the usual number. In not a few cases the apices of (apparently) totally different species have been found upon examination to be identical in every way; thus, *Murex Tryoni*, Hidalgo, *M. Cailleti*, Petit, and *M. Similis*, Sowb., have the same form of apex which does not vary in the minutest degree. Due allowance must be made, of course, for the wear to which the shell is subjected, as in many cases the carina might be totally obliterated by wear, and thus give the entire apex a different appearance.

The present condition of the synonomy of this group, is a continual and perplexing bar to the solution of the problem of specific identity, and will remain so until large quantities of specimens have been gathered from well authenticated localities, and when more is known concerning the soft parts.

Genus MUREX, Linn.

Subgenus *Murex* (Sensu Stricto).

MUREX TRIBULUS, Linn.

FIG 5.

The nucleus consists of one and a half brownish glossy whorls; a carina begins at the apex, encircles the embryonic whorls and finally runs into the lowest spiral liræ of the succeeding whorl; this carina is very faint and only to be seen by the aid of a powerful lens; the extreme point is bent down to one side and the tip is immersed in the body of the second whorl; the first half of the apex, looking at the lateral outline, is about two-thirds the size of the second half; the whole whorl is decidedly knob shaped and rapidly increases in size from the apex to its juncture with the matured portion of the shell; there is a slight varix at the ending of the embryonic whorls; the succeeding whorls are crossed by four spiral liræ; the spines begin upon the fourth whorl.

This species was first described in my former paper (p. 68), but after its publication I found that what had been identified as *tribulus*, was really *Martinianus*, Reeve. This species has been placed by some authorities as a synonym of *tribulus*, but the two species seem to be quite distinct. I have examined upwards of twenty specimens of each species, and there is no intermingling of characters.

The general character of the present apex is quite different from any hitherto described.

Subgenus *Rhinocantha* A. Ad.

MUREX BRANDARIS, Linn.

FIG 1.

The embryonic nucleus consists of one and a half rounded glossy, smooth whorls, of which the second half is but little larger than the first; the tip of the apex is bent down to one side and concealed in the succeeding portion of the whorl; there is no carina and the whorls are smooth and glossy in texture, and of a light horn color; a view of the lateral outline shows a well rounded profile with rather a strong varix at the left side; after passing this varix, the whorls are crossed by four spiral liræ, which are made nodulus by the crowded condition of the varices; the suture of the embryonic whorl is well developed and a trifle impressed. This apex resembles that of *Murex brevispina*, *M. nigrospinosus* and *M. recurvirostris*, but is at once distinguished by the absence of a carina near the base of the last whorl. It more nearly resembles that of *Murex similis*, except that the whorls are more rounded than those of *brandaris*.

This is the only species of the *Rhinocantha* group (there are but two, the other being *cornutus*, *L.*) that I have been able to study. I have before me eight specimens of this species all in perfect condition, and the apex shows no variation.

Subgenus *Chicoreus* Montf.

MUREX RUFUS, Lam.

FIG. 2.

The embryonic apex of this species consists of one broad, flat whorl, which is of a reddish or rosy tinge; the tip is immersed in the body of the spire, and is considerably bent down to one side; there is no carina and the whorl is rough and coarse in texture, nearly approaching to granulose; there is no varix at the ending of the embryonic whorl, but the four spiral liræ, and the longitudinal costæ gradually appear and grow stronger as the shell increases in size; the whole apex of the shell for three whorls from the top is of a deep rose color.

Of this species I have seen three examples in perfect condition and the characters expressed in the above diagnosis show little or no variation.

Murex Salleanus, A. Ad, may be included here as a synonym. I have examined many hundred of this species from Florida, Yucatan, and the West India Islands, and do not for a moment hesitate in referring this species to *rufus*.

MUREX PLICIFERUS, Sowerby.

Fig. 4.

The apex of this species consists of two and a half rounded, waxy whorls of gradual increase; the first, or tip, is a little oval knob, which is not bent down or immersed as in most of the species examined; a carina begins at the very apex, encircles the shell just above the suture below, and finally enters the suture below the third whorl; there is a varix of considerable size at the ending of the embryonic whorl, which is rounded and transparent; after passing this varix the whorls are longitudinally costate, there being nine costæ to each whorl; these are crossed by four narrow, thread-like spiral lines; the spinose varices appear upon the fifth whorl.

I have before me four specimens of this species in perfect condition, and have seen nearly a dozen more in good condition, and the characters of the apex appear constant. The number of embryonic whorls is a condition not possessed by any member of the *chicoreus* group which I have examined. The spiral carnia encircling all the whorls is also a prominent character.

Pliciferus was considered by Mr. Tryon* a synonym of *calcar*, Kiener. I have examined specimens of both forms and do not hesitate to separate them as good and distinct species. *M. pliciferus* was first described by the elder G. B. Sowerby in Zool. Proc. 1840, p. 138, and first figured in Conch. Ill., Murex, f. 101, from a single specimen in the Cumingian collection. Since that time numerous specimens have been collected from the China coast and I have had the pleasure of examining quite recently a fresh lot of nearly a hundred specimens. It is a beautiful species of yellowish color and when full grown measures four inches in length.

MUREX BREVIFRONS, Lam.

Fig. 3.

The embryonic apex of this species consists of about two rounded, rather smooth whorls; the tip of the apex is bent down to one side, and immersed in the coil of the succeeding whorl; the second whorl is but little larger than the first, after the latter leaves the extreme point; there is no indication of a carina; the whorls succeeding the two embryonic, are longitudinally ribbed until about the fourth is reached when the first varices appear; they do not become spinose until about the fifth; there are four spiral lines crossing the whorls, after passing the embryonic; the texture of the apex is more or less hyaline and rather shining.

I have examined eleven specimens of this species and the characters expressed above show no variation.

The synonomy of this species appears to be rather mixed and for the purpose of bringing it together I give below a table containing all the known synonyms.

* Manual of Conchology, vol. 2, p. 94.

PLATE 11.

NEW SPECIES OF MURICIDÆ, &C.

1. *Astralium Wardii.*

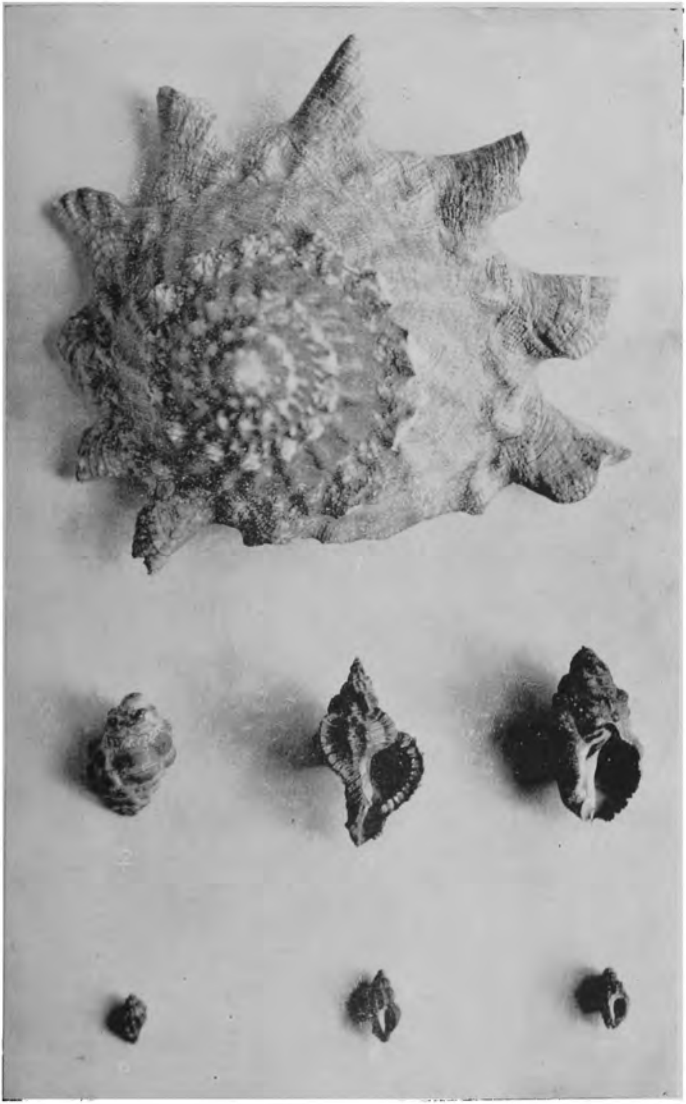
2–3. *Purpura problematica.*

4. *Murex bituberculatus.*

5. *Ocinebra Wardiana.*

6–7. *Ocinebra rubra.*

ALL THE FIGURES ARE NATURAL SIZE.



Baker—New Species of Muricidæ.

MUREX BREVFIRONS, Lam. Anim. Sans. Vert., IX, p. 573, Synonyms :

Calcitrapa, Lam. Anim. Sans Vert., IX, p. 573.
Crassivaricosus, Reeve. Zool. Proc., 1845. p. 86.
Elongatus, Reeve. (non Lam.) Conch. Icon.
Purpuratus, Reeve. Conch. Icon., sp. 183.
Approximatus, Sowb. Thes. Conch., 13 f. 62, 1879.

Description of New Species.

During the past six months I have had occasion to examine and study a large number of species and specimens of the *Muricidæ*, and among them I found four which appeared new to science. Of these, two may eventually prove merely varieties of nearly allied forms, but at present the paucity of material fully warrants their description as novelties. The types are in my private collection of *Muricidæ*.

MUREX (CHICOREUS) BITUBERCULATUS, sp. nov. Pl. 11, Fig. 4.

Shell oblong, ovate, rather thin, chocolate colored ; whorls eight, crossed by three longitudinal varices on each whorl with two intervarical nodes between each varix ; spire acute, pyramidal, about half the length of the entire shell ; sutures distinct, slightly impressed ; the body whorl is crossed by nine coarse spiral lines with a finer line between ; on the canal these lines are all of the same size ; the whorls are gracefully rounded and stand out upon the surface of the shell in great prominence ; the surface is further ornamented by extremely fine longitudinal lines, which intersects the spiral lines giving rise to small nodules at their intersection ; on the varices the spiral lines are raised into heavy, erect lines, giving the varix a crenulated aspect ; aperture a long oval ending below in a wide canal ; collumella arcuate, smooth and partly covered by a thin callous ; outer lip thickened by the varix, crenulate upon its edge ; canal moderate, wide, open nearly straight ; umbilicus closed ; color light chocolate, the nodes darker and the liræ lighter than the body of the shell ; apical whorls two in number, smooth and hyaline.

Alt. 34, diam. 18 mill. Aperture (excluding canal) alt. 12, diam. 8 mill. Habitat : *Australia.*

This species has long been a puzzle to me and it remained in my collection unnamed for a long time. I finally had an opportunity of comparing it with a large collection, and with all the published descriptions of the members of the *Chicoreus* group, and was convinced, after a careful study, that it was an undescribed species.

It can only be compared with *Murex Thomasi* Crosse, its nearest ally, from which it is separated by the two intervarical tubercles, there being but one in *Thomasi*. The spiral liræ are coarser and fewer in number in *Thomasi* than in the new species. The spire of *bituberculatus* is higher and the general aspect of the two shells is quite different.

OCINEBRA WARDIANA, sp. nov. Pl. 11, Fig. 5.

Shell fusiform, thick, rather solid of a cinereous color; whorls five, rounded, crossed by numerous rounded, elevated, longitudinal ribs which are encircled by thread-like spiral liræ; spire rather acute, outline of whorls rounded; sutures impressed; there are nine longitudinal ribs on the last whorl which are elevated and rounded; these are crossed by about eighteen large, somewhat scabrous lines, with occasionally a finer line between; aperture ovate; outer lip rounded and thickened by the last longitudinal varix; inner margin of outer lip provided with seven well-developed denticles; collumella area covered by an extending callous, smooth; interior of aperture light-rosy; canal short, wide, closed, a little recurved; umbilicus closed, surrounded by a strong fasciole; color yellowish overlaid by a blackish epidermis.

Alt. 14, diam. 7 mill. Aperture (excluding canal) alt. 5, diam. 3 mill. Habitat: *Australia.*

This is a pretty little shell having a superficial resemblance to *Ocinebra aciculata* Lam., but separated from that species by the more developed umbilical region, greater development of the tubercles within the outer lip and in the less accuminate spire. The color of the two shells is quite different, that of *aciculata* being light rosy, while *Wardiana* is yellowish or cinereous. *Wardiana* is also a more robust species than *aciculatas*, and the general shape of the two species is quite different. Unfortunately the apex is broken so that I am unable to describe that interesting and valuable portion of the shell.

The habitat of *Wardiana* will at once separate the two species, *aciculata* being from the Mediterranean Sea and Atlantic coasts of Europe and the British Channel. The new species is from Australia.

I take great pleasure in dedicating this interesting little species to Prof. Henry A. Ward, of Rochester, New York, who has for many years been a student of conchology and who has collected in many portions of the world.

OCINEBRA RUBRA, sp. nov. Pl. 11, Figs. 6, 7.

Shell fusiform, solid, reddish to chestnut in color; whorls four (the apex is broken off on all the specimens so that but four whorls can be counted), stongly shouldered and crossed by strong, raised longitudinal ribs and spiral lines; spire rather short and occupying about half the length of the entire shell; there are on each whorl eight or nine strong raised, longitudinal costæ, which are crossed by six strongish, raised spiral lines arranged in pairs, two being at the shoulder, two at the periphery, and two at the base of the whorl; the intersection of these longitudinal and spiral lines cause the shell to be cancellated or pitted, the pits being squarish or quadrate; between each pair of spiral lines is a finer spiral line of a thread-like character; spire rather stumpy; sutures well defined; whorls above the shoulder, between the shoulder and the suture, deeply excavated by the crossing of the longitudinal and spiral lines; aperture ovate, white within; canal short, moderately wide and closed; columella smooth, white; outer lip strongly arcuate and five-toothed within, the denticles forming nearly raised tubercles; umbilicus defined but closed; color red or chestnut overlaid by a lighter epidermis; aperture white within.

Alt. 12, diam. 7 mill. Aperture (excluding canal) alt. 4, diam. 2, mill. Habitat unknown.

This species belongs to the *alveata* and *Peasei* group of Murices, but from the material at hand appears to be distinct from any thing hitherto published. The shell is shorter in the spire than *alveata* Kiener, and the aperture is much larger in proportion than *Peasei* Tryon (*foveolata* Pease), It has some resemblance to the figures of *Ocinebra interfossa* Cpr., but does not at all correspond with specimens of that species. I think there is very little danger of its being confounded with any other shell.

The species of Ocinebriæ are very numerous, and the material ordinarily at the disposition of the student very small, so that no satisfactory catalogue of the group has as yet been published; and the species described in this paper as new, may eventually prove to be of the many unfigured species, which have been described with brief Latin diagnoses and have not been identified by subsequent authors. Many of these descriptions have been very brief, of scarcely three lines, and furthermore without dimensions of any kind. Such careless work does not deserve recognition, and the species so described should be consigned to oblivion. The task of the monographer has not been an easy one on this account. A perusal of Sowerby, Reeve and Tryon will convince the student of the truth of my statements.

PURPURA (THALESSA) PROBLEMATICA, sp. nov. Pl. 11, Figs. 2, 3.

Shell strong, solid, chocolate colored under a cinereous epidermis; spire conical, occupying about half the length of the entire shell; whorls about five in number, crossed by four spiral riblets on the body whorl which are cut into nodules giving the shell the appearance of a mulberry ; the body whorl is encircled by ten spiral lines, two between each of the series of nodules ; the nodules are further crossed by numerous microscopical lines which are only to be seen with the aid of a glass ; the lateral outline of the whole shell is more or less fusiform ; the upper row of nodules gives the shell a shouldered appearance and the character is continued to the apex ; aperture ovate—oblong ; columella smooth but twisted at its base ; outer lip crenulated externally, and three toothed or denticled within, the denticles prolonged in long processes which are continued to the apex ; anterior canal a mere notch ; posterior canal slightly developed ; umbilical region covered by the columella callous which is provided near the center with a narrow thread-like fold ; columella muscle scar placed near the posterior canal, square and chestnut colored ; aperture light-yellowish within, the inner edge of the outer lip stained with black.

Alt. 30, diam. 18 mill. Aperture alt. 17 diam. 8 mill. Habitat : *Japan.*

This species is closely related to both *Purpura hippocastaneum*, Lam., and *P. tumulosa* Reeve. From *hippocastaneum* it is separated by the tubercles being nearly obsolete and not spinose ; the whole shell smaller, more fusiform and of a more compact form. The spire is more conical and the whorls flatter than in the latter species.

From *tumulosa* it is separated by its smaller size, its greater length as compared with its width, and by the presence of *teeth within the outer lip*, a character *not* possessed by *tumulosa.*

The species was first diagnosed from three specimens without locality, obtained from the Wagner Free Institute of Science of Philadelphia, Penn. Sometime afterwards nine additional specimens were received from Japan, thus confirming the validity of the species and giving, fortunately, an authentic locality. I have twelve specimens of these species now before me and there is no variation from the above diagnosis.

This species is well figured on pl. 46, f. 48 of the second volume of Tryon's Manual and is in that work considered to be a variety of *tumulosus*, but from a comparison of abundant material, seems to be distinct.

Description of a new species of Astralium.

ASTRALIUM (POMAULAX) WARDII, sp. nov. Pl. 11, Fig. 1.

Shell large, depressed conic, imperforate ; rufescent with a tinge of green ; whorls six, sloping, conical, obsoletely longitudinally wrinkled below the sutures ; periphery expanded, carinated, armed with ten wide spines, the spines being cut into narrow cinguli by the lines of growth ; there is a row of nodules running spirally around the shell just above the peripheral spines which upon the last and penultimate whorls are greenish in color, but which become white upon the upper whorls ; there are about twenty-two of these nodules to each whorl ; base planulate with about thirteen concentric tuberculate spiral lines encircling it ; umbilical region white, with two strongish ribs, one at the end of the callous and the other forming part of the columella ; texture of surface, both above and below the periphery, granulose ; aperture transversely dilated, angulate ; interior of aperture pearly ; columella callous depressed.

Alt. 42, diam. 108 mill. Aperture alt. 20, diam. 40 mill. Habitat: *Australia.*

This large and beautiful shell is closely related to *Astralium japonicum*, Dunker,* and may prove but a variety of that species. *Wardii* is a much wider and a more depressed shell than *japonicum*, and the peripheral spines are more developed. The dimensions of the two species are very different and I give them both below to show their relative proportions.

Japonicum. Alt. 65, diam. 95 mill.

Wardii. Alt. 42, diam. 108 mill.

This shell was collected by Prof. Henry A. Ward, to whom the species is dedicated, in Australia some years ago and now forms part of his large and fine collection of shells.

The operculum is unfortunately unknown.

JANUARY 26, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Twenty-two persons present.

The following paper was read :

THE ZODIACAL LIGHT.

BY M. A. VEEDER.

There is in or near the plane of the ecliptic, at a distance from the sun greater than that to which the glow of twilight or dawn extends, a faintly luminous cone or band known as the zodiacal light. Under

*Described in Phillippi Abbild., Vol. 1, Pl. 5, Fig. 1, 1845.

exceptionally favorable circumstances this band has been traced completely across the sky. In that portion of it which is most remote from the sun there has been found a spot brighter than the rest, which has been called the gegenschein. The zodiacal light is brightest in the tropics, and in that location has been thought by some to exhibit pulsations. Its spectrum however is usually continuous, indicating that it shines by reflected sunlight. Auroral or other lines have been detected in its spectrum only exceptionally and under such circumstances that they may perhaps have been due to intermixture of light from other sources.

In the middle latitudes the zodiacal light is brightest in March and October, in the former case after sunset, and in the latter before sunrise. At these times one margin of the band is better defined than the other, and more exactly included within the plane of the ecliptic. At other seasons there is decreasing brightness, and both edges become ill defined. It does not seem possible to explain these differences fully by referring them to variations in the angle made with the horizon, or to the interference of twilight. The peculiarities mentioned, and others yet to be described, are consistent with the idea that the zodiacal light is a visible extension of the solar corona.

This extension of the corona is probably double, corresponding to the bifurcation seen during eclipses, each section overlying a sunspot belt. It consists doubtless of meteoric particles of the usual ferruginous character, moving in definite orbits, and shining by reflected light. It is a solar appendage, but not a part of the sun's atmosphere. Like the rings of Saturn, it does not conform to the plane of the earth's orbit but to that of the equator of the body which it surrounds, which in this case is the sun itself. As viewed from the earth these coronal extensions are at times foreshortened, and at times opened out, so as to become more plainly visible. In the spring months the south pole of the sun is inclined toward the earth, so that the latter is almost exactly in the heliocentric zenith of the southern sunspot belt and coronal extension. Consequently the particles composing this extension are in a direct line between sun and earth, and shining as they do by reflected light, like the new moon, they become almost invisible. Coincidently the coronal extension overlying the northern sunspot belt is opened out to its widest extent, and reflects more light earthward than at any other time. Hence if these extensions become visible as the zodiacal light, the southern edge at this season should be the more sharply defined, and more exactly include within the plane of the ecliptic, because of the lack of illumination described, and the northern edge on the other hand, should shade off very gradually departing more widely from the plane of the ecliptic, and this is precisely what has been found to be the case. At this time of year also the northern coronal extension, thus opened out to its greatest extent, is in full view on the sunset side of the plane of the earth's orbit. In Autumn, on the other hand, the north pole of the sun is directed earthward, and the northern coronal extension fails of illumination, and the southern coronal extension is opened out and most completely illuminated, and is in full view on the sunrise side of the plane of the earth's orbit. Thus the zodiacal light is brightest in Spring and Fall, but in the evening in the one case and in morning in the other. In Summer and Winter, on the other hand, the earth occupies a position intermediate between these disc-like coronal extensions. Coincidently the zodiacal column becomes less clearly defined on both edges and diminishes greatly in brightness, less light being reflected earthward, and it is seen equally well, though faintly, both in the morning and in the evening.

It is in their relation to magnetic phenomena, however, that the peculiarities of the zodiacal light acquire their greatest interest. Indeed the present research probably would not have been undertaken had it not grown out of the investigation in regard to the aurora and its associated phenomena, some of the results of which were presented before the Academy and printed in the Proceedings of Nov. 11, 1889. (See page 18.) At that time evidence of a periodicity of auroras at intervals of about twenty-seven days had been secured. Subsequently, with more complete information and longer lists, this period was amended by successive approximations until it became twenty-seven days, six hours, and thirty-six minutes. It was then for the first discovered that this result, which had been obtained independently from magnetic phenomena alone, differed only four minutes from the most generally accepted value for a synodic revolution of the sun, as determined from the average rate of movement of sun spots. For the sake of uniformity this four minutes was added, and tables were constructed, (see plate,) showing the numbers of stations reporting auroras each day in all accessible lists for nearly two hundred years, arranged in periods of twenty-seven days, six hours, and forty minutes each. Portions of these tables comprising forty-six years were compared with the coincident records of magnetic perturbations at Greenwich, and for three years with records from the Naval Observatory, Washington, and likewise with the results obtained at Point Barrow, in connection with the International Polar Expedition in 1882 and 1883. The consensus of all this very voluminous testimony is to the effect, that there is an unmistakable periodicity at an interval which does not differ very much, if at all, from that finally adopted as above stated. This periodicity is, however, subject to modifications which require further investigation. The chief of these are certain annual interruptions which are plainly apparent in the accompanying plate. At first it was supposed that these were due to the interference of moonlight, or summer twilight, as the case might be, preventing auroras from being seen. But the records of magnetic perturbation which are not affected by moonlight show the same thing, so that further explanation is required.

By the identification of the disturbed portions of the sun, concerned in the production of particular series of outbreaks of magnetic phenomena, we may learn whether cessation of solar activity attends the annual interruption in the recurrence of auroras to which reference has been made. For the purpose of such identification the surface of the sun was considered to have been divided meridionally into as many sections as there are days, and fractions of a day, required for the completion of a single synodic revolution. Lists were then made of all sunspots observed on each section, together with their sizes, as determined by the measurements made at Greenwich Observatory upon the photographs, taken under the auspices of the Solar Physics Committee of the Royal Society. The sums of the numbers, indicating the sizes in each of these lists for the entire period selected, show the corresponding amount of sunspot formation on each section. The numbers of stations reporting auroras each day during the period selected, were also arranged in accordance with the time of a synodic revolution, and the sums for corresponding days of all these synodic periods were obtained. By this means the portion of the sun associated with a given series of outbreaks of magnetic phenomena at once becomes apparent. Thus it appears that the areas most frequented by sunspots are most actively concerned in the production of auroras, having this power occasionally, even when spots are temporarily absent, and in any case manifesting it chiefly, if not exclusively, when at the eastern limb, appearing by rotation. As regards explanation of the interruptions at regular intervals of series of recurrences of auroras, it appears from the tabulation here described that they cannot be accounted for by cessation of solar activity.

This tabulation, by increasing our knowledge of the nature and consequence of solar activities, may contribute positively to the explanation of the interruptions of series of auroras in question.

The association of phenomena indicated and their periodicity, afford positive proof that the body of the sun is a coherent mass prob-

PLATE 12.

TABLE SHOWING PERIODICITY IN OCCURRENCE OF AURORAS.

The accompanying table has been constructed by counting the stations, reporting auroras each day in the Monthly Weather Review of the United States Signal Service, and arranging the numbers thus obtained in periods of twenty-seven days six hours and forty minutes. The six hours, or one-quarter day, is provided for by adding a day to each fourth period, and the forty minutes, or one-thirty-sixth, day by adding a day to each thirty-sixth period. The grouping together of larger numbers indicates increased prevalence of the aurora at this interval, which corresponds to the time of a synodic revolution of the sun. Annual interruptions of such series of recurrences are also apparent. (See columns 4 to 10 and 18 to 24).

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	¼	1/16
1885	Feb.16 to Mar.15	3	3				2	1	1			1							2	7	2						2	9	72	·
	Mar.16 to Apr.11	7	2	2	1	14	4					1					1			1			1	15	2	1	1			
	Apr.12 to May 8	2	3	4	1					1	1	1					3							1		2	1	2		
	May.9 to Jun.4	5		19	1	21			1		1							2	2	7				1	4	1	3	2		
	Jun.5 to July 2	1		1	4			1		2		1	1		1	1			2	2	14	5	1				1		1	
	July 3 to July 29			2							2	1		1	1	1	1			1	1		1			1				
	July 30 to Aug 25	1	1	6	4		1		9	5	2	1		2	1	1	1	1	1		1									
	Aug.26 to Sep.21	1	1	1	3		1	1	2	9	15	2									10	46	1	3	2					
	Sep.22 to Oct 20					1	2		1							1		16	2		13	2	2	4	8	4	1	1	*	*
	Oct.21 to Nov.16								1	3	1	5	5						1	11		19	5	5	3		1			
	Nov.17 to Dec 13	1														14	2		1	1	28	15	7	1						
	Dec.14 to Jan.9				1									1			1	1		5	2	1	1			2	5	8		
1886	Jan.10 to Feb.6	4	3	1		3						1		1	1			1		6	8	2			2	5		1	6	
	Feb.7 to Mar.5	7	7	1	8	1	1	1			1	1					6		2				1			1	1	1		
	Mar.6 to Apr.1	3	1		1	2	1	3			1	1	1	1	1		2	3		1		18	5	15	1	13	6	11		
	Apr.2 to Apr.28	2	1	3		1		1			3	3		13					2	16				3	3					
	Apr.29 to May 26	2	8	4	1	1		1		1	37	18	1	1	1	3	1			4			4	3	1	1	1	1	1	
	May 27 to Jun.22		2	2	2		2	1	2	23	19	1			1		1								1	3				
	Jun.23 to July 19	1	3	1	2	2	1	47	21	1	8	2	1	1		1	1				2				1			1		
	Jul.20 to Aug.15	1		9	1		2	3	96	9					1		2	1		2				3	2	3	2			
	Aug.16 to Sep.12	1	3			3	1	1	64	3	1	3	1												1	2	6	1	*	
	Sep.13 to Oct.9	1	1	1		2		1	12	2	1	1				1		6	11	8	2		2	4	6	11	12	2		
	Oct.10 to Nov.5	1		2				1	1	7			3	2		1	1	4	10	24	4	3	1		12	8	7	2		
	Nov.6 to Dec.2	2	1							1	1			1		3	1	2	7	1	2		1		4	4	3	2		
	Dec.3 to Dec.30		1			1					1			1		2			1		4	1		3	2		4	3	*	
1887	Dec.31 to Jan 26	1							1							2		3	1	3		1		5	1	2	2	1		
	Jan.27 to Feb.22			1				1		1						1	7	33	23	9	2	5	1	1	42	6	4	1		
	Feb.23 to Mar.21	3	1	4	1		1	1							2					2		3				5	5	2		
	Mar.22 to Apr 18		5	4								2									1	a			a	a			a	
	Apr.19 to May 15	4				5		1			2				4	2	1							1	6	1	1			
	May 16 to Jun 11		3	7	2	1	1	2	19	16	5	1					1	1		2		2				3	3	1		
	Jun 12 to July 8			1	1	1	1	2	1	2	1	1				3	1	1							1	5	1			
	July 9 to Aug 5				1		1	3		2	13	15	4												1				*	
	Aug.6 to Sep 1				1		1		5	12	4	2				1			2					4	3		2	1		
	Sep 2 to Sep.28					3					1	1	1	2	11	5	3	1			5	3	2	3	40	2	13	1		
	Sep.29 to Oct.25				1			1			2		3		3	6				1			1	2	7		1			
	Oct.26 to Nov.22														9	4			1	1	1	2		2	1	5	2	2	1	
	Nov.23 to Dec.19														4	1	1				8	7	2	1	8	5	1			
	Dec.20 to Jan.15	1	12	1							1								1	9	10	1	2		3	9	4	2		
1888	Jan.16 to Feb.11	4	3						1	2	1		1	1				1		4	5	2			40	1	2	1		
	Feb.12 to Mar 10			1	1			5	4	2				2							1					12	2	1	1	
	Mar.11 to Apr 6		1			18	4	6	4			2		1	1						5		2	76	17	5	8	1		
	Apr. 7 to May 3	1			5	57	8	11	3	5															2	4	5	1		
	May 4 to May 30	1	1	6	28	6	6	1		1			1			2		55	6	2					1	2	3	1		
	May 31 to Jun.28	1	2	4	20	2	2					1	2		1	2													*	*
	Jun.29 to July 25		5	3						1									1	1					1					
	July 26 to Aug 21			3	2				3	15		1						5	1	1	1	1	4	3	1					
	Aug.22 to Sep.17					1				1	2	2	1					1	1	2		2	3	3	4	1		1		
	Sep.17 to Oct.15							1		2		2	1			2		2						5	10				1	
	Oct.16 to Nov.11	1			2		2				1	1			1	40	7	1			1	4	3	1			1			
	Nov.12 to Dec.8	1	1			1	1								3	2	1			2	1		2	2	2		1	2		

VEEDER—ZODIACAL LIGHT.

ably containing a solid nucleus, and that it is not entirely liquid or gaseous as some have supposed. At certain points in this mass, there is something akin to volcanic action in progress. On the earth such action is attended by electrical phenomena, and this is probably the case upon a much grander scale on the sun. Indeed, the evidence is conclusive that these solar eruptive forces are concerned in the production of disturbances of terrestrial magnetism, at intervals of about twenty-seven days, as well as in eleven year cycles, and at more or less irregular intervals. The next step is to inquire how these solar electric impulses are conveyed from sun to earth.

It is a well known principle, that when bodies in a condition of electrical strain with reference to each other are put in motion they become the seat of currents of electricity. Thus, in the telephone, a thin plate of metal is adjusted in proximity to a magnet so as to be held in a condition of strain. When put in motion by the sound of the voice, this plate vibrates to and fro, varying its distance from the controlling magnet, and as the result electrical currents are generated. By means of a wire these currents are conducted to a second instrument in which they modify the attractive force of another magnet in such manner, that it causes vibrations in a plate under its control, entirely similar to those imparted at the outset by the sound of the voice. It is motion, therefore, which under proper conditions generates electrical currents. Thus the motion of the sun on its axis, carrying forward at an enormous velocity the electrically excited portions of its surface, generates currents which tend to propagate themselves, as is the rule, along certain lines of force. It is for reasons connected with these peculiarities of magnetic induction that disturbances at the eastern limb alone are capable of conveying the strongest electrical impulses earthward. In the conduction of such impulses there is not an actual conveyance of material substance from one point to another, but each particle intervening, that is capable of serving as a conductor, tends to become a magnet and arrange itself with reference to every other particle in its vicinity, in accordance with the principle of polarity, as is seen when iron filings attach themselves to a magnet. In the case of the telephone the varying stress or strain is conveyed by means of the conducting wire, the particles composing which are magnetized, or in other words, tend to become magnets. Without such conducting medium there can be no conveyance of currents, even for comparatively short distances, to say nothing of ninety-five millions of miles.

Now we have in the disc-like extensions of the solar corona, which become visible as the zodiacal light, such a distribution of ferruginous meteoric particles, as would serve as a conducting medium, not only from sun to earth, but much farther, as appears from the presence of the zodiacal band and gegenschein, shining faintly though it be, in the part of the heavens most remote from the sun. The probability that these coronal extensions serve as conductors of electrical impulses originating in the sun will be strengthened in proportion as it is found that the diurnal, annual and other variations of terrestrial magnetism are directly related to the varying location of the earth, and of the disturbed parts of the sun in reference to these discs.

In Spring and Fall the earth, as we have seen, is traversing one or the other of these coronal extensions, and it is at these seasons as a rule that auroras are most brilliant and numerous, the earth then being in the very midst of the conducting magnetic material. Thus certain interruptions in the recurrences of similar magnetic conditions, to which reference has been made, may at length be explained. They are due simply to the varying position of the earth itself in respect to the conducting medium.

There is evidence, also, that it makes a difference as to which hemisphere a solar disturbance is located upon. In 1888, and for several years preceding, there were series of bright auroras at the interval from each other of a synodic revolution of the sun, which were confined almost entirely to the Spring and early Summer months of each year; these series being interrupted almost completely at other seasons. (See columns 4 to 10 of plate.) It is likely in this case that the originating solar disturbance was confined to one hemisphere of the sun, and in proper relation to one coronal extension only, so that its full effect was experienced by the earth for a limited period recurring annually. In another case, likewise extending over several years, the originating solar disturbance seems to have been of such extent as to involve both coronal discs, the result being greater persistence of magnetic phenomena throughout the entire year, but with the customary pronounced maxima due to the position of the earth in Spring and Fall. (See columns 18 to 24 plate.) Thus another series of the interruptions and modifications of periodicity to which reference has been made, may be accounted for by differences in the position of solar disturbances, with respect to the coronal discs, which serve as the conducting medium for the conveyance of the impulses which they originate.

Other effects of the varying position of the earth in reference to these coronal extensions and other effects of their varying inductive power, remain to be described. Thus the permanent magnetic poles of the earth are displaced from the poles of its axis of rotation a distance almost exactly equal to the inclination of the latter to the plane of these extensions of the corona. Induction at this angle, continued through long series of years, seems to have established the latitude of the magnetic poles, their location in longitude being determined, perhaps, by the magnetic properties of the materials of which the earth itself is composed.

Changes in the sub-permanent magnetism of the coronal extensions, resulting from the variability manifest in the sun, necessarily cause slow variations in the strength and location of the permanent magnetic poles. Thus the well known secular variations of declination and magnetic dip become explicable. Changes in the temporary magnetism of these same coronal conducting discs, such as must exist during magnetic storms, will on the other hand, occasion the induction of temporary magnetic poles in the same latitude as the permanent poles, but undergoing a diurnal change of longitude. The inductive effect is exercised at a fixed point as regards the coronal extensions, but different parts of the earth come under its influence in succession, because of the diurnal motion of rotation. Near the track which this temporary pole traverses, during magnetic storms, the needle is much more disturbed, and auroras are brighter than elsewhere. Thus, also, these phenomena are at their height at the hours of local time, when this temporary pole is brought nearest to the point of observation by the revolution of the earth on its axis. Once in twenty-four hours this temporary pole coincides with the permanent pole, re-enforcing the effect of both, and occasioning the absolute maximum of auroras for that day. Thus an aurora has been observed to attain its greatest brightness at about ten o'clock P. M., local time, in many different localities from Russia westward to Alaska, its greatest absolute brightness however being at the time of its closest approach to the permanent magnetic pole near Hudson's Bay. During magnetic storms there is at midnight a reversal in the direction of the characteristic deflections of the needle, evidently due to the changing location of this temporary magnetic pole. When magnetic storms persist for several days the curves recorded by the declination magnetograph, not infrequently are almost precisely similar both as respects direction and extent, at corresponding hours each day. So, too, in the case of very severe magnetic storms the needles have been observed to have been thrown into a state of agitation at practically the same instant throughout the earth, but the direction and extent of the movements in different localities are not the same, being dependent upon proximity to the temporary pole, in the manner above indicated.

Still another form of induction from these coronal discs is due to the orbital motion of the earth in reference to them. In this case also a wandering pole is developed, but unlike that just described it undergoes very large changes of latitude as well as longitude. Its effect is apparent in smooth and sweeping deviations of the needle, which recur daily and are entirely different from the fitful and irregular movements characteristic of magnetic storms. These deviations depend for the most part upon the persistence of the permanent and sub-permanent magnetism of the coronal matter, rather than upon sudden variations in the extent of its magnetization. They consist of a large deflection eastward during the morning hours and a corresponding westward deflection about noon, and similar movements eastward and westward but upon a very much smaller scale during the night. In Winter this diurnal variation is very much less than in Summer, and the time of its occurrence is slightly modified. This appears to depend upon a transference of the wandering pole, which has been developed, from the Winter to the Summer hemisphere of the earth because of some relation which this latter hemisphere sustains to the direction of the orbital motion. In other words, the earth's axis remaining parallel to itself, and at a certain angle with the plane of its orbit, induction due to orbital motion will have its chief effect first in one hemisphere, and then in the other, according to the situation of the earth in its annual course about the sun. The revolution of the earth on its axis brings all points on its surface more or less directly under the influence of this pole, at certain hours of local time, the proximity and consequent effect being greater in Summer than in Winter. There is, therefore, in this case, a compounding of diurnal and annual periodicity. Also in years when sunspots and auroras are numerous the range of this regular diurnal movement increases, probably because of the increase of the sub-permanent magnetism of the coronal particles.

There is evidence also that other members of the solar system beside the earth are affected by magnetic induction of solar origin. There are regular variations of the needle which depend upon the position of the moon. The tables of auroras show likewise that magnetic phenomena acquire greater intensity when the moon is in certain parts of its orbit. This was noticed moreover by Sir John Franklin, in the case of auroras in the Arctic regions. There is evidence too that the planets Jupiter and Saturn, in certain parts of their orbits, react upon each other and upon the earth by magnetic induction. These are phases of the subject, however, which have not been studied as yet, except in an incidental way.

It will be observed that no account has been made of any presumed variability of solar heat. The forces concerned in the various forms of periodicity described, whatever else they may be, do not appear to be thermo-electric. It is inconceivable that puffs of heat should be conveyed from disturbances at the eastern limb, or any other point on the sun exclusively, so as to originate a periodicity, such as that manifest in the case of auroras. The electrical impulses are conveyed, not as heat radiations, but in accordance with ordinary principles of magnetic induction, bearing no other than merely incidental relations to heating effects. Nor is there any conclusive evidence that these impulses are conveyed as light radiations. Indeed, some of the chief effects which they produce are confined to the darkened side of the earth. In short the preponderance of evidence is to the effect that they constitute a special form of solar activity, having well defined peculiarities and standing apart from the rest.

It will be observed also that no reference has been made thus far to the idea that tidal strain due to planetary positions may originate the conditions in the sun upon which magnetic phenomena depend. The writer has been unable to reconcile the eleven year period and other peculiarities with any schedule of planetary positions thus far devised. On the other hand the somewhat irregular character of the periodicity, and the ways in which it tends to manifest itself all indicate that the originating forces in the sun are chiefly, if not entirely, volcanic. At times of apparent solar quiet, there is an accumulation of energy which bursts forth when a certain limit has been reached, causing the characteristic rapid increase of sunspots, auroras and magnetic storms at the beginning of each fresh cycle of solar activity, which in turn is followed by the usual comparatively slow decline. In a viscous mass, such as that of which the sun probably very largely consists, eruptions will be most likely to recur with considerable regularity, as they do in the case of the terrestrial volcano Kilauea, whose lavas are characterized by unusual viscidity. Thus the eleven year period may be simply of solar volcanic origin.

As bearing upon the manner in which the explosive forces manifest at certain points on the sun, originate and propagate electrical impulses, the various facts in regard to the zodiacal light acquire very special interest. The purpose of the present discussion has not been so much to elaborate a working hypothesis, although perhaps this is really involved, as to present a compendious account of phenomena actually observed in their natural relation to each other. It is a continuation of the research some of the results of which were presented before the Academy and printed in the Proceedings last year under the headings "The Aurora" and "The Forces Concerned in the Development of Storms."* The conclusions set forth in those papers are in conformity with what has been stated in the present discussion. The most practical result thus far attained is perhaps the securing of evidence that the belt-like distribution of atmospheric pressure about the magnetic poles as a center, which varies in different years and in different parts of the same year, producing different types of weather, is very largely dependent upon magnetic induction of solar volcanic origin conveyed from sun to earth through the medium of the coronal extensions which become visible as the zodiacal light.

FEBRUARY 9, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Twenty-four persons present.

The Council report recommended,

(1) The payment of certain bills.

(2) That the Academy appropriate $6.50 for the construction of a case to hold a collection of fossils, presented to the Academy by PROF. A. L. AREY.

The items of the report were separately adopted, the bills ordered paid, and the appropriation made.

The candidates for Fellowship, nominated at the previous business meeting, were elected by formal ballot.

The following paper was read:

NOTES ON MEXICAN ARCHÆOLOGY.

BY F. W. WARNER.

The numerous temples and other archæological remains found in Mexico, are mostly of Toltec origin. The temples were used by the Aztecs in the exercise of their superstitious rites and it is quite probable that their religious ceremonies were especially adapted to the buildings which they found when they came into the country. Some of the temples, and among them the great pyramid of Cholula, were in exist-

* See Proceedings of November 11, 1890, pp. 18 and 57 of this volume.

ence when the Toltecs first made their appearance in Mexico, about the year 680.

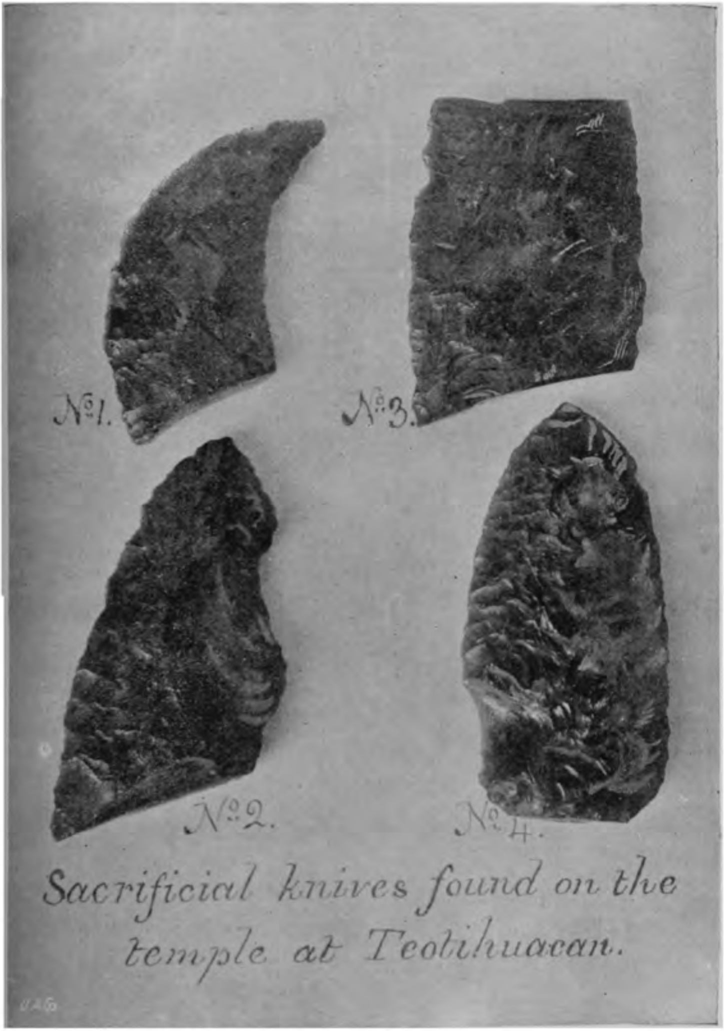
Forty miles east of the city of Mexico there is found a very remarkable group of temples at a place called San Juan Teotihuacan. From the size and extent of the pyramids and the other ruins, as well as from the great number of pieces of pottery and broken implements scattered over miles of territory, it is evident that this was once a large city and a center of worship: an Aztec Jerusalem or Mecca. The principal pyramid of Teotihuacan is mentioned in the old records as the To-na-ti-uh, Itz-a-cu-atl, or the Temple of the Sun.

This structure is made in the form of a truncated pyramid, and though the sharp angles have been somewhat rounded by time, the pyramidal form is retained. The temple is overgrown with weeds and cactus, but the stairway and the terraces are clearly cut, though somewhat obscured by the verdure.

The pyramid stands upon a raised platform or foundation which may or may not be included in the measurement. The building covers an area of 12 acres and rises to a height of 202 feet above the elevated area about it, and 216 feet above the level of the plains. The measurements are usually given, without including the raised platform, as 700 feet on each side of the base; my own measurement made it fall short a few feet of that figure. A Mexican writer, Señor Cubas, includes the base and makes it 768 feet on the sides running north and south, and 720 feet on the sides running east and west. The flat space at the top covers about half an acre and upon it there is a large altar of mason work still standing. The approach to the summit is by a zigzag stair case, and there are two narrow terraces passing completely around the pyramid, each measuring a third of the distance from the base. The building is made of small stones and broken rock firmly cemented together with lime. On one side a deep cut has been made, showing the solid and uniform nature of the work.

From the summit of this pyramid we may survey the entire field and get a good idea of the size and position of the lesser pyramids. To the north, and slightly to the west, is the pyramid known as the Temple of the Moon, while to the south and east are twelve smaller pyramids called the *Temples of the Stars.* These are arranged so as to enclose a court or hollow square. Each side has four pyramids and is about a mile in length, thus enclosing a square mile. The smaller pyramids are each about one hundred feet square at the base and forty-two feet in height. The temple of the moon is well worth a careful study. It is distant 2,700 from the temple of the sun, and, as I have indicated, a little to the west of north. The pyramid is 137 feet in height and 511 feet on a line of the base on the north and south sides, and 426 on the east and west base lines, covering exactly five acres. On the west face of the pyramid is a large opening disclosing a horizontal passage. This leads in for a distance of about forty feet, where it terminates in a well about fifteen feet in depth. The object of this chamber is left to conjecture. Lying about two hundred feet from the west side is a sculptured rock of porphyry, which once served as the sacrificial stone, while near the north side lies a sculptured image also of porphyry which once stood upon the summit of the temple. These valuable relics of the Toltecs were rolled from their position and mutilated by order of Bishop Zumar-ra-ga, who made such havoc of the Aztec and Toltec records, and spent his energies in trying to destroy every trace of the heathen races, believing that the natives would the more readily embrace the christian faith. Coming down the stairway on the southern face of the pyramid, you come into the the Camina de la Muerta, or way of death, which terminates on this face. This way is laid in cement and is as smooth and clean as a floor. It is about a hundred feet in width and between three and four thousand feet in length. The paved way is laid in levels and any change of level is marked by a descent of steps which are of the full width of the road. As one can imagine, a stairway a hundred feet in width is a striking architectural feature. On either side of this pavement are imposing structures from twenty to sixty feet in height, some in pyramidal form and some are built square with cornices. The pavement for its entire length is lined on both sides with these buildings which were used as tombs. The southern end of the pavement terminates in a large square structure of solid masonry, which has a heavy cornice. Looking from this point the architectural effect is imposing in the extreme. The broad pavement with the stairway of full width is sunken deep between the rows of tombs and terminates far away in the stairway of the pyramid. This wonderful pavement, with the tombs and terminal temples, is one of the grandest archæological studies on the continent.

Some two miles away from these remains we came upon several large buildings. One of them was 60 feet in length by 28 in width. The walls were standing about four feet high, with a doorway in the face only. Two rows of columns were left standing about the same height as the outer walls. I visited this place first in 1874 and again in 1875. I made a third visit to the place ten years later. During my first visit I was astonished at the number of "finds." In a search of an


No. 1.
No. 3.
No. 2.
No. 4.
Sacrificial knives found on the temple at Teotihuacan.

hour, on and about the pyramids, I picked up nearly a peck of curious objects which consisted mostly of implements of obsidian knives, spear points and arrow tips. But the most common of the objects were the images and little heads (cabacitas) of terra cotta, which were found lying around everywhere. Some of these were quite grotesque. The accompanying cuts are taken from the figures picked up near the temple of the sun, but are considerably reduced in size.

Fig. 1.

Fig. 2.

Fig. 3.

"Cabacitas,"—or Little Heads found near the Temple of the Sun.

Fig. 4.—Terra Cotta image found at San Juan Teotihuacan.

The early Aztec writers quoted by Prescott, Lord Kingsborough and others, give accounts of the use made of these temples in the offering of human sacrifices. In the year 1486, at the dedication of a temple to their god, Huit-zil-o-poch-tli, it was recorded that seventy thousand human beings were sacrificed upon a single altar. In making the sacrifice a peculiar form of knife is described as being used by the priests in opening the breast before removing the heart. The knife is made of obsidian and is formed like a pruning knife with a curved point and with two cutting edges.

In talking with Mexican archæologists while in the city of Mexico, my attention was called to the fact that, although the peculiar curved form of the sacrificial knives is carefully described in connection with the accounts of the human sacrifices, no such knife had ever been found or ever existed in any collection. Considerable doubt has been expressed as to the truth of the Aztec accounts of these human sacrifices, on account of the lack of the corroborative evidence of the sacrificial knife. I examined carefully the public and private collection in Mexico and could find nothing different from the straight two-edged knife. I naturally reasoned that if these knives ever existed otherwise than in the imagination of the early chroniclers, they would be found about the altar on the summit of the Temple of the Sun at

FIG. 5. STONE TROWEL, SIZE 6 x 2½ INCHES.

Teotihuacan, where so many bloody scenes of human sacrifice were said to have taken place.

I made an expedition to this place in 1875, and by a few moments digging about the altar on the summit, I was rewarded by finding four fragments of knives. All of them were nearer than six inches to the surface.

Judging from the place where I found these relics, I think that all of them are fragments of sacrificial knives, although they do not all show the convex and concave cutting edges.

Number one in the accompanying cut is unmistakably the point of a sacrificial knife. The concave edge is so decided as to leave no doubt as to its design.

Number two, though not having the concave cutting edge, is different in form from the ordinary obsidian knife, and has no doubt been used in the human sacrifice. The fracture from the shorter cutting edge may have been caused by prying against a human rib in opening the breast to reach the heart, as was required by the Aztec priest.

Number three is a fragment of a well formed knife, while number four is the ordinary form of the Aztec knife made from the itztli. From the fact that it was found at the base of the altar, we may infer that it played some part in the human sacrifices.

These fragments are all made from obsidian, and the cut represents them in their exact size.

Number one has attracted considerable attention among Mexican archæologists, and is important as corroborating the account of the human sacrifices. In digging at the base of the temple, I found a trowel shaped stone, (Fig. 5,) which might have been used in the mason work of either building or in repairing the temple. A piece which is almost the exact counterpart of this stone is in a large private collection in Mexico, and, before my finding this, was thought to be a unique example of an Aztec mason's trowel.

FEBRUARY 23, 1891.

STATED MEETING.

The President, Prof. H. L. FAIRCHILD, in the chair.

Thirty-five persons present.

The additions to the library were announced.

MR. J. E. PUTNAM spoke of the peculiar sensation produced by electricity. He had recently received a severe shock, which had rendered him quite unconscious for a few seconds. The current was received through a hand and bare arm, the strength of the current being about two hundred and forty volts. The sensation experienced was like a flash of lightning passing before the eyes. The effect was over in the fraction of a minute.

The Secretary, Mr. Frank C. BAKER, gave an illustrated lecture on

EXPLORATIONS IN YUCATAN AND SOUTHERN MEXICO.

(*Abstract.*)

The lecturer briefly outlined the course of the scientific expedition sent out by the Academy of Natural Sciences of Philadelphia, under the charge of Prof. Angelo Heilprin. The expedition left New York City Feb. 15, 1890, and returned June 10, 1890, having traversed the northern part of Yucatan and Southern Mexico, from Vera Cruz to Jorullo. Two of the party, Prof. Heilprin and the speaker, ascended and took barometric measurements of Orizaba, Popocatepetl, Ixtaccihuatl, Nevada de Toluca and Jorullo. The heights of the first four mountains as finally determined, are as follows :

Orizaba	18205 ft. alt.
Popocatepetl,	17523 "
Ixtaccihuatl	16960 "
Nevada de Toluca,	14954 "

Large collections in Zoology, Botany, Geology and Mineralogy were made.

The lecture was illustrated by blackboard diagrams, photographs and numerous specimens.

MARCH 9, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Sixty persons present.

The Council report recommended :

(1.) The payment of certain bills.

(2.) The election of the following candidates as resident members:

MR. GEO. H. ASHLEY,
MR. EDMOND N. GUERET.

(3.) That the Academy extend an invitation to the American Association for the Advancement of Science to hold its Annual Meeting of 1892 in the City of Rochester, and that the other institutions of city, and the city government, be asked to join in the invitation.

The bills were ordered paid, the candidates elected by formal ballot, and the resolution unanimously adopted.

It was moved and voted that the Council be empowered to carry the resolution of invitation into effect, in the name of the Society.

Under deferred business the following change in the By-Laws, proposed Nov. 10th, 1890, was considered and adopted unanimously.

Resolved, that Section 5, Chapter XIII, of the By-Laws be changed to read as follows:

The Council shall have power to remit the fees or dues of individual members or fellows, provided that such remission shall not be anticipatory in its effect.

A lecture on

A VISIT TO THE GRAND CAÑON OF THE COLORADO, ARIZONA,

was given by MR. CHAS. D. WALCOTT, Chief Palæontologist, United States Geological Survey.

Illustrated by charts, models and lantern slides.

A vote of thanks was given the lecturer.

MARCH 23, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

A very full attendance.

The collection of local fossils recently presented to the Academy by Prof. A. L. Arey, was exhibited, and a vote of thanks extended to him by the Academy.

The following paper was read by title :

CATALOGUE AND SYNONOMY OF THE RECENT SPECIES OF THE FAMILY MURICIDAE.

First Paper.

BY FRANK C. BAKER.

The following Catalogue is based upon a five years' study of the family ; a majority of the species have been examined, and all the literature upon the subject to the present date carefully compiled. In many cases the material at my command has been ample for the satisfactory adjustment of the synonomy ; in other cases, where the type specimens were only known, or where there was a paucity of material for examination, I have followed the best authorities, not, however, without a careful study of the original figures and descriptions, There are several species in this catalogue which will, in all probability, become synonyms when an abundance of material is obtained for their study, but at present I have thought it best to admit them as valid species until more is definitely known concerning them. It will be noticed that several references have been omitted after some of the specific names; these were not found in any work accessable to me, and I have only given such information as I could find.

In no group of mollusks is the specific distinction more difficult of determination than in the Muricidae ; shells inhabiting a sandy or muddy, sheltered locality, will be thin and elegantly frilled, while the same species from a rocky, exposed locality will be thick and almost smooth. The degree of spinose development is no criterion, inasmuch as a series of specimens from a single locality will show every degree of development, from simply nodulous to the most pronounced condition of spinosity. The soft parts in many species are nearly identical, but the opercula show some very good characters.

The larval shell, or nucleus, appears to afford good specific characters, and I have availed myself of this feature in many cases. Unfortunately the specimens are usually received by the student in an imperfect condition, and almost invariably with the apex either broken off or eroded. In a lot of 250 *Murex brandaris* recently examined by myself there were but ten specimens with a perfect apex, and in a lot of 200 *Murex adustus*, not a single specimen was perfect. These specimens were received direct from the original collectors and had not been tampered with by middlemen. This illustration shows the difficulty under which the student works while studying this interesting branch of Malacology.

There are doubtless many who will disagree with me regarding some of the species admitted in this catalogue as valid, which have been by Tryon and others included in the synonomy, or as varieties of other allied species. In the present catalogue I have admitted as valid any species which can be distinguished from another by good characters, and which is not seen, in an abundance of material, to intergrade into other forms.

During the past ten years several European conchologists have separated certain species of the family into sections, but they are not stable, and the characters used merge into each other so that it is impossible to determine just where certain of the species belong in these sections. As an example of this splitting up I cite the gerus *Typhis*, which is divided by Jousseaume into twelve sections; there are but fifteen species in the genus. Such work seems to me hardly worthy the consideration of the true conchologist. Our science is now overburdened with generic, sub-generic and sectional names, and it is simply absurd to give a group name to every two or three species which happen to differ in a slight degree from their congeners.

I trust this catalogue will be found useful to conchologists in arranging their collections, and while by no means perfect, yet I feel confident that it is a step in advance of its predecessors.

Family MURICIDÆ, Fleming, 1828.

Sub-family MURICINÆ, H. AND A. Adams, 1853.

Genus MUREX, Linn.

Syst. Nat., X, ed., 746, 1758.
Purpura, Humphrey, Mus. Callon.
Aranea, Perry, Conch., t. 45, 46, 1811.

Sub-genus MUREX, Linn. (Sensu stricto.)

Haustellum, Klein., Ostracol, 63, 1753.
Brontes, Montf., Conch. Syst., ii, 622, 1810.
Haustellaria, Swains., Malacol., 296, 1840.
Acupurpura, Bayle, 1880, Fischer, Man. Conch., p. 641.
Tubicauda, Jouss, 1880, Fischer, Man. Conch., p. 641.

1. **Murex scolopax,** Dillw. Cat., II, 681.
Tribulus-maximus, Chemn., conch. cab., t. 189, f. 1819, 1820.
crassispina, Kiener, t. 4, f. 5.
Forskali, Bolten, Mörch.
hystrix, Martini Conch. cab. III, 363, t. 113, f. 1052.
hystrix, Martini, Mörch, Yoldi Cat., 98.
Red Sea; Indian Ocean; China.

2. **Murex occa,** Sowb., Zool. Proc., 137, 1840. Conch. Ill., f. 45.
China.

3. **Murex Macgillivrayi,** Dohrn, Zool. Proc., 203, 1862.
Lizard Isles, Australia.

4. **Murex tribulus,** Linn., Syst. Nat., edit. XII, p. 1214.
unidentatus, Sowb., Conch. Ill., f. 52 (Orig. list).
rarispina, Sowb., (non Lam.) Conch. Ill., f. 52.
crassispina, Lam., Anim. Sans Vert., IX, 564.
Red Sea; China; Japan.

a. var. *nigrospinosus*, Reeve, Zool. Proc., 88, 1845. Conch. Icon., sp. 79.
Indian Ocean.

b. var. *aduncospinosus*, Beck, Reeve, Conch. Icon., f. 93.
ternispina, Sowb., (var.) conch. Ill., f. 68.

Red Sea.

c. var. *Carbonnieri*, Jouss., Le Naturaliste, No. 44, p. 349; Nouvelles Archives du Museum, p. 31, t. 4, f. 1a, 1b, 1882.

China.

5. **Murex acanthodes** Watson, Journ. Linn. Soc. London 1883, p. 599; challenger Gastropoda, p. 151, t. 10, f. 1.

Australia, 3–12 *fms.*

6. **Murex Coppingeri,** E. A. Smith, Zool. Voyg. H. M. S Alert, p. 42, t. 5, f. a.

Arafura Sea, Dundas Strts, 17 *fms.*

7. **Murex serratospinosus,** Dunker, Mal. Blatt., 1883, p. 35, t. 1, f. 45.

Island of Flores.

8. **Murex acanthostrephes,** Watson, Journ., Linn. Soc. London, 1883, p. 596; Challenger Gastropoda, p. 149, t. 10, f. 2.

West of Cape York, 28 *fms.*

9. **Murex ternispina,** Lam., Anim. San Vert., IX, p. 566.
tenuispina, Quoy (not Lam.), Voy. Astrolabe, II, 528, t. 36. f. 3, 4.

I. O.; Japan; China; Phil.

10. **Murex tenuispina,** Lam., Anim. San. Vert., IX, p. 566.
tenuirostrum, Lam., Anim. San. Vert., IX, p. 569.
tribulus-duplicatus, chemn., conch. cab., t. 189, f. 1821; t. 190, f. 1822.
duplicatus, Mörch., Yoldi Cat., p. 98.

I. O., Japan; Australia.

11. **Murex Martinianus,** Reeve, Zool. Proc., 188, 1845; conch. Icon., sp. 72.
trapa, Bolten, Mörch, Yoldi cat., 98.

China; Japan.

12. **Murex Troscheli,** Lischke, Jap. Moll.

Japan.

13. **Murex sobrinus,** A. Ad., P. Z. S., 267, 1851.

Japan, 29 to 55 *fms.*

14. **Murex Cabritii,** Bernardi, Journ. Conch., VII, 301, t. 10, f. 3, 1858.

West Indies, 50–164 fms.

15. **Murex concinnus,** Reeve, Conch. Icon., sp. 104.
Locality unknown.

16. **Murex plicatus,** Sowb., Conch. Ill., f. 6.
unidentatus, Menke, Zeitsch., 1850.
W. C. Cent. Am. to Gulf of Cal.

17. **Murex recurvirostris,** Brod., P. Z. S., 174, 1832.
messorius, Menke, Zeistch, 1850.
Panama.

18. **Murex messorius,** Sowb., Conch. Ill., f. 93.
funiculatus, Reeve, Zool. Proc., 88, 1845.
lividus, Cpr., Mazat. cat. 519, 1856.
Gundlachi, Dunker, (described where ?)
Cedar Keys to Aspinwall.

a. var. *rubidum*, Dall, Blake Gastropoda, 1889.
Cedar Keys.

b. var. *nigrescens*, Sowb., Conch. Ill., f. 113.
Panama.

19. **Murex eximius,** Brazier, Proc. Linn. Soc. N. S. Wales, 170, 1877.
N. Australia, 30 *fms.*

20. **Murex Tryoni,** Hidalgo, Manual of Conch., Tryon, p. 134, t. 70, f. 427, 1880.
(= *M. Cabrittii*, Bern. Young ?)
Lesser Antilles.

21. **Murex rectirostris,** Sowb., Conch. Ill., f. 111.
China ; W Columbia.

22. **Murex Mindanensis,** Sowb., Conch. Ill., f. 92.
Mindanao, Philippines.

23. **Murex Beaui,** Petit, Jour. de Conch.. v, 295, t. 8, f. 1, 1856.
West Indies.

24. **Murex pliciferus,** Sowb., Zool. Proc., 138, 1840; Conch. Ill., f. 101.
Japan.

25. **Murex superbus,** Sowb., P. Z. S., 1888, p. 565, t. 28, f. 10, 11.
Japan.

26. **Murex calcar,** Kiener, Coq. Viv., t. 36, f. 2.
Senegambia.

27. **Murex Antillarum,** Hinds, Zool. Proc., 126, 1843.
nodatus, Reeve, Conch. Icon., sp. 107.
West Indies.

28. **Murex rarispina,** Lam. An. San. Vert., IX, 567.
unidentatus, Sowb., Conch. Ill., f. 32. (Provisional list.)
formosus, Sowb., Conch., Ill., f. 112.
coronatus, Sowb.. Thes. Conch., f. 199. (Not Adams.)
Indian Ocean.

29. **Murex similis,** Sowb., Conch., Ill., f. 70.
West Indies.

30. **Murex motacilla,** Chemn., Conch. Cab., IX, t. 163, f. 1563.
West Indies.

a. var. *Caileti*, Petit, Journ. de Conch., V, 87, t. 2, f. 1, 2, 1856.
West Indies.

b. var. *elegans*, Beck, Sowb., Conch. Ill., f. 84.
trilineatus, Reeve, Conch. Icon., sp. 103.
West Indies.

31. **Murex chrysostoma,** Gray, Sowb., Conch. Ill., f. 1.
bella, Reeve, Zool. Proc., 88, 1845; Conch. Icon., sp. 84.
variegatus, Mart., A. Ad., Gen. I, 98.
West Indies.

32. **Murex brevispina,** Lam., An. San. Vert., IX. 567.
Red Sea; I. O.; S. Africa.

a. var. *senilis*, Jouss., Rev. et Mag. de Zool., t. 1, f. 5, 6, 1874.
Philippines.

33. **Murex haustellum,** Linn., Syst. Nat., Ed. XII, p. 1214.
Red Sea; I. O.; China; Mauritius; Philippines.

a. var. *longicaudum*, Baker, Proc. Acad. Nat. Sci. Phila., 1891, p. 56.

Subgenus BOLINUS Pusch. 1837.

Fischer, Man. de Conch., p. 641.

Rhinocantha, H. and A. Adams, Genera, 1853.

34. **Murex brandaris,** Linn., Syst. Nat., Ed. XII, p. 1214.
brandariformis, Locard, Ann. Soc. Agric. Lyons, vol. 8, p. 164; Ann. Soc. Linn. Lyons, 1885, p. 219.

coronatus, Risso, Eur. Merid., IV, 190, f 78.
rudis, Michelotti, Monog., p. 14.
subbrandaris, d'Orb., Prodr. Pal. 72.
trunculoides, Pusch, Polens, Palaeont, 136, t. 11, f. 23.

a. var. *trifariospinosus* Chemn., Frauenfeld, Vehr. Zool. Bot. Gessell., 889, 1869.

trispinosus, Locard, Ann. Soc. Linn. Lyons, 1885, p. 219.
Mediterranean.

35. **Murex cornutus,** Linn., Syst. Nat., Ed. XII, p. 1214.
tumulosus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 71. (Young.)
Mediterranean.

Subgenus PTERONOTUS, Swainson.

Malacol, 296, 1840.
Pterynotus, Swains., Elem., 19, 1835.
Naquetia, Jouss., 1880, Fischer, Man. Conch. p. 641.
Morchia, Jouss., 1880, Fischer, Man. Conch. p. 641.
Triremis, Bayle, 1880, Fischer, Man. Conch. p. 641.
Poropteron, Jouss, 1880, Fischer, Man. Conch. p. 641.
Pteropurpura, Jouss., 1880, Fischer, Man. Conch, p. 641.
Alipurpura, Bayle, 1884, Fischer, Man. Conch. p. 641.

36. **Murex trigonulus,** Lam. Anim. San. Vert., IX, 581.
triqueter, Kiener, Coq. Viv.. t 40, f. 3.
pulcher, A. Ad. of Sowb., Thes. Conch., f. 119, 1879.
Gambia, Africa.

37. **Murex triqueter,** Born. Mus. Cæs., t. 11, f. 1, 2.
trigonulus, Kiener, Coq. Viv. t. 25, f. 2.
Cumingii, A. Ads., Zool. Proc. 270, 1851.
Cumingii, Sowb., Thes. Conch., f. 115, 1879.
roseotinctus, Sowb., Zool Proc., 429, t. 32, f. 6, 1859.
Red Sea; I. O.; Phil.; Paumotus; Mauritius.

38. **Murex rubridentatus,** Reeve, Zool. Proc., 1846.
Habitat unknown.

39. **Murex Barclayi,** Reeve, Zool. Proc., 209, t. 38, f. 2, 1857.
Mauritius.

40. **Murex triformis,** Reeve, Zool. Proc., 87, 1845, Conch. Icon., sp. 53.
acanthopterus, Sowb., var., Conch. Ill., f. 51.
Port Jackson, Australia.

41. **Murex bipunctatus,** Sowb. Thes. Conch., p. 22, f. 188, 1879.

Australia.

42. **Murex acanthropterus,** Lam. Anim. San Vert., IX, 577.

Watson's Bay, N. S. Wales.

43. **Murex alabaster,** Reeve, Zool. Proc., 86, 1845.

Philippines.

44. **Murex canaliferus,** Sowb., Zool Proc 142, 1840, Conch. Ill., f. 74.
cancellatus, Sowb., Zool. Proc., 143, 1840.

Habitat unknown.

45. **Murex lingua,** Dillw., Desc. Cat., II, 688.
gibbosus, Lam., Anim. Sans Vert., IX, 580.
jatonus, Brug., Encyc. Meth., t. 418, f. 1.
lingua vervecina, Chemn., Conch. Cat., X, t. 161, f. 1540.

W C. Africa.

a. var. *flavidus*, Jouss., Rev. et Mag. de Zool., 8, t. 1, f. 7.
rusticus, Jouss., Rev. et Mag. de Zool., 8, t. 1, f. 7, 1874.

W C. Africa.

46. **Murex hemitripterus,** Lam., An. San. Vert., IX, 579.
gibbosus. Kiener, (juvenile) Coq. Viv., t. 7, f. 4
jatonus, Sowb., Conch. Ill., f. 60.

Senegambia.

47. **Murex abyssicola,** Crosse, Jour. Conch., XIII, 30, t. 1, f. 4, 5, 1865.

Guadeloupe, W I

48. **Murex Adamsi,** Kobelt, Jahr. Mal. Gesell., IV, 154, 1877.
alabaster, A. Ad., Zool. Proc., 508, 1863.

West Indies.

49. **Murex macropterus,** Desh., Mag. Zool., t. 38, 1841.

Off Cape Hatteras, 63 fms.

50. **Murex tripterus,** Born, Mus. Cæs., t. 10, f. 18, 19.
trialatus, Kiener, Coq. Viv., t. 31, f. 2.

Red Sea; I. O.; Philippines.

51. **Murex pinnatus,** Wood. Ind. Test. Suppl., t. 5, f. 20.
pellucidus, Reeve, Zool. Proc., 86, 1845; Conch. Icon., sp. 54.
alatus, Bolten, Mörch. (described where ?)
Martinianus, Pfr , Krit. Reg., 8.

China.

52 **Murex clavus,** Kiener, Coq. Viv., t. 37, f. 2.
bipinnatus, Reeve, Zool. Proc., 85, 1845.
uncinarius, Sowb., Conch. Ill., f. 106.

Philippines.

53. **Murex osseus,** Reeve, Zool. Proc., 87, 1845.
Gambiensis, Reeve, Zool. Proc., 88, 1845.

Gambia River, W. C. Africa.

54. **Murex speciosus,** A. Adams, Zool. Proc. 121, 1855.

Japan.

55. **Murex Lobbeckei,** Kobelt., Jahrb. Deutsch, Malak. Gesell., vol. 6 p. 78; vol. 7, p. 80, t. 3, f. 2.

Indian Ocean?

56. **Murex Bednalli,** Angas, Proc. Zool. Soc., 1880, p. 418, t. 40, f. 2.

Port Darwin, Australia.

57. **Murex percoides,** Löbbecke, Jahrb. Deutsch. Malak. Gesell., vol. 6, p 78; vol. 7, p. 80, t. 3, f. 1.

China?

58. **Murex uncinarius,** Lam. Anim. San. Vert., IX, 379.
mitriformis, Sowb., Conch. Ill., f. 75.

Cape of Good Hope.

59. **Murex phaneus,** Dall, Bull. Mus. Comp. Zool., Harvard College, vol. 18, pt. 2, p. 201; Proc. U. S. Nat. Mus., vol. XII, 1889, p. 330, t, 11, f. 1.

Off St. Augustine, Florida, 434 fms.

60. **Murex tristichus,** Dall, Bull. Mus. Comp. Zool., Harvard College, vol. 18, pt. 2, p. 202, t. 15, f. 3.

Off Cuba, 152-450 fms.

61. **Murex cordismei,** Watson, Journ. Linn. Soc. London, vol. 16, p. 601; Challenger Gastropoda, p. 156, t. 10, f. 5.

Bass Strait, 38 fms.

62. **Murex Angasi,** Crosse, Journ. Conch., XI, p. 86, t. 1, f. 2, 1863.
eos, Hutton, Journ. de Conch., 3 ser., XVIII, 12, 1878.
zonatus, Woods, Proc. Roy. Soc. Tasmania, 132, 1876.

Australia; New Zealand.

63. **Murex quinquelobatus,** Sowb., Thes. Conch., p. 22, f. 218, 1879.

Habitat unknown.

Subgenus CHICOREUS, Mont.

Conch. Syst., II, 610, 1810
Siratus, Jouss., 1880, Fischer, Man. Conch., p. 641.
Euphyllon, Jouss., 1880, Fischer, Man. Conch., p. 641.
Inermicosta, Jouss., 1880, Fischer, Man. Conch , p. 641.

64. **Murex palma-rosæ,** Lam. Anim. San. Vert , IX, p. 572.
arginna, Meuschen, Mörch, Yoldi Cat.. 97.
Indian Ocean.

65. **Murex Maurus,** Brod., Zool. Proc., 174, 1832.
Sauliæ, Sowb., Zool. Proc., 141, 1840; Conch. Ill., f. 77.
affinis, Reeve, Conch. Icon., sp. 182.
Moluccas; Philippines; E. Indies.

66. **Murex microphyllus**, Lam., An. San. Vert., IX, 576.
Poirieri, Jouss., Nouv. Arch. du Mus., 1882, 58, t. 4, f. 2, a. b.
Jousseaumi, Poirier, Nouv. Arch. du Mus., 1882, 58, t. 1, f. 1, a. b.
Indian Ocean.

67. **Murex Banksii,** Sowb., Conch. Ill., f. 82.
Bourguignati, Poirier, Nouv. Arch. du Mus., 1882, 57, t. 5, f. 2, a. b.
Moluccas.

68. **Murex torrefactus**, Sowb., Zool. Proc., 141, 1840; Conch. Ill., f. 120.
Steeriæ, Reeve, Zool. Proc., 85, 145; Conch. Icon., sp. 28.
microphyllus, Kiener, Coq. Viv., t. 23, f. 1.
Rochebruni, Poirier, Nouv. Arch du Mus., 1882, 57, t. 5, f. 1, a. b.
rubiginosus, Reeve, Zool. Proc. 86; 1845; Conch. Icon., sp. 32.
China.

69. **Murex adustus,** Lam. An. San. Vert., IX, 373.
trivialis, A. Ad., Zool. Proc., 71, 1853.
despectus, A. Ad., Zool. Proc., 72, 1853.
fuscus, Dunker, Jap. Moll.
versicolor, Gesell., Mörch.
I. O., Philippines; Japan.

a. var. *Huttonæ*, Wright, Sowb., Thes. Conch., f. 57, 1879.
New Caledonia.

b. var. *Australiensis*, Angas, Zool. Proc., 72, 1853.
Australia.

70. **Murex rufus,** Lam., An. San. Vert., IX, 574.
Salleanus, A. Ad., Zool. Proc., 70, 1853.
pudoricolor, Reeve, Zool. Proc., 108, 1845; Conch. Icon., sp. 168.
Florida; Yucatan; West Indies; *Indian Ocean.*

a. var. *florifer*, Reeve, Conch. Icon., sp. 188.
Honduras.

71. **Murex multifrondosus,** Sowb., Thes. Conch., p. 16, f. 192, 1879.
Australia; I. Ocean.

72. **Murex palmiferus,** Sowb., Conch. Ill., f. 104.
N. Australia.

a. var. *dilectus*, A. Ad., Zool. Proc., 120, 1855.
Habitat unknown.

b. var. *corrugatus*, Sowb., Conch. Ill., f. 72.
Australia; I. O.

73. **Murex Hidalgoi,** Crosse, Journ. de Conch., XVII, 408, 1869; 3 ser., XI, 68, 1871.
West Indies.

74. **Murex territus,** Reeve, Zool. Proc., 108, 1845; Conch. Icon., sp. 167.
Sydney, Australia.

75. **Murex Penchinati,** Crosse, Jour. de Conch, IX, 351, t. 16, f. 6, 1861,
Liu-Tschiu Islands.

76. **Murex nubilus,** Sowb., Zool. Proc. 428, t. 49, f. 4, 1859.
Habitat unknown.

77. **Murex Rossiteri,** Crosse, Jour. de Conch., XX, 74, 228, t. 13, f. 2, 1872.
Lifou Isl.; Loyalty Group; N. Caledonia.

78. **Murex Thomasi,** Crosse, Journ. de Conch, XX, 212, XXI, t. 11, f. 4, 1872-3
Marquesas Archipelago.

79. **Murex bituberculatus,** Baker, Proc. Roch. Acad. Science, vol. 1, p. 113, t. 11, f. 4.
Australia.

80. **Murex cervicornis,** Lam., Anim. San. Vert., IX, 575.
I. O.; Torres Sts., Austr., 20-30 *fms.*

81. **Murex longicornis,** Dunker, Novit. Conch., 64, t. 22, f. 5, 6, 1864.

Amboina.

82. **Murex recticornis,** Martens, Jahrb Deutsch. Malak. Gesell , vol. 7, 81, t. 4, f. 3.

East Australia, 76 *fms.*

83. **Murex monodon,** Sowb., Tankerv. Cat. App., 19, 1825.
aranea, Blainv., Kiener, t. 36, f. 1.

Japan; Torres Strs., Austr.

84. **Murex axicornis,** Lam., Anim. Sans. Vert., IX, 574.

Indian Archipelago.

a. var. *spectrum*, Reeve, Conch. Icon., sp. 187.

imbricatus, Higgins & Marrat, Proc. Litt. & Phil. Soc. Liverpool, XXXI, 413, t. 1, f. 2, 1876-7.

Grenada.

b. var. *aculeatus*, Lam. Anim. San. Vert., IX, 575; Sowb. Conch. Ill., f. 63.

Moluccas.

85. **Murex rubescens,** Brod., Zool. Proc., 174, 1832.

Taheiti.

86. **Murex anguliferus,** Lam., Anim. San. Vert., IX, 588.
Erythræus, Fischer, Journ. Conch., XVIII, 177, 1870.
cyacantha, Sowb., Thes. Conch., f. 160, 1879.
anguliferus, Vaillant, Jour. Conch., XIII, 105, 1865.
rudis, Link, Mörch, Yoldi Cat., 97.
virgineus, Bolten, Tapp. Mur. Mar. Rosso., 14.

Red Sea; I. O.; Seycheles; I. Bourbon.

a. var. *ferrugo*, Wood. Ind. Suppl., t. 5, f. 16.

Red Sea.

b. var. *ponderosus*, Chemn., Conch. Cab.

Ceylon.

87. **Murex clausii,** Dunker, Jour. de Conch., 213, t. 8, f. 6, 1879.

Gulf of Guinea, W. Africa.

88. **Murex Senegalensis,** Gmel., Syst. Nature, 3537.
Brasiliensis, Sowb. Conch. Ill. f. 55.
costatus, Gmel., Syst. Nat. 3549.
sirat, Adams, Seneg., 125, t. 8, f. 19.

Senegal.

89. **Murex Gubbi,** Reeve, Conch. Icon., sp. 193, 1849.
W. C. Africa.

90. **Murex Leanus,** Dall, Proc. Nat. Mus., vol. XII, 1889, 329, t. 7, f. 1.
Cerros Isl.; L. Cal., 44 fms.

91. **Murex capucinus,** Lam., Anim. San. Vert., IX, 576.
monachus-capucinus, Chemn., Conch. Cab., XI, t. 192, f. 1849, 1850.
Philippines; Valparaiso; Porto Rico.

92. **Murex fasciatus,** Sowb., Zool. Proc., 144, 1840.

93. **Murex ramosus,** Linn., Syst. Nat., Ed. XII, 1215, partim.
frondosus, Mörch., Yoldi Cat., 97.
inflatus, Lam., Anim. Sans. Vert., IX, 570.
incarnatus, Bolten, Mörch, Yoldi Cat., 67.
Red Sea; I. O.; China; Isle. Bourbon; N. Zealand; Austr.; Pacific Ocean.

94. **Murex elongatus,** Lam. Anim. S. Vert., IX, 571.
Sinensis, Reeve, Zool. Proc., 85, 1845; Conch. Icon. sp 25.
Ind. Ocean; China.

95. **Murex brevifrons,** Lam., Anim. San. Vert., IX, 573.
purpuratus, Reeve, Conch. Icon., sp. 183.
crassivaricosus, Reeve, Zool. Proc., 86, 1845; Conch. Icon., sp. 33.
approximatus, Sowb., Thes. Conch., 13, f. 62, 1879.
elongatus, Reeve, Conch. Icon.
Brazil; W. Indies.

a. var. *Calcitrapa*, Lam., An. San. Vert., IX, 573.
Red Sea; I. O.; China.

96. **Murex Toupiollei,** Bernardi, Journ. de Conch., VIII, 211, t. 4, f. 5, 1860.
Habitat unknown.

97. **Murex crocatus,** Reeve, Zool. Proc., 108, 1845; Conch. Icon. sp. 168.
West Indies.

98. **Murex Jickelii,** Tapparone, Mur. Mar. Risso., 18, t. 15, f. 6, 1875.

99. **Murex laciniatus,** Sowb., Conch. Ill., f. 39.
scabrosus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 73.
Philippines.

100. **Murex laqueatus,** Sowb., Zool. Proc., 142: 1840; Conch. Ill., f. 78.

Habitat unknown.

101. **Murex angistoma,** Küster, Conch. Cab., II, 88, t. 31, f. 7.

Habitat unknown.

102. **Murex Benedictinus,** Löbbecke, Jahrb. Deutsch. Malak. Gesell., vol. 6, p. 79.

Indian Ocean.

103. **Murex pomum,** Gmelin, Syst. Nat., 3527.
pomiformis, Martini, Mörch, Yoldi Cat., 96.
oculatus, Reeve, Zool. Proc., 86, 1845; Conch. Icon., sp. 36.
Mexicanus, Petit, (young) Journ. Conch., III, 51, t. 2, f. 9, 1852.
asperrimus, Lam., Anim. Sans Vert., IX, 576.

Subgenus PHYLLONOTUS, Swainson.

Malacol. 296, 1840.
Muricanthus, Swain., Malacol. 296, 1840.
Hexaplax, Perry, Conchology, 1811.
centronotus, Swains., Elem. Conch., 1835.
Bassia, Bayle, 1880, Fischer, Man. Conch. p. 641.
Poirrieria, Jouss., 1880, Fischer, Man. Conch. p. 641.
Paziella, Jouss., 1880, Fischer, Man. Conch. p. 641.

104. **Murex rosarium,** Chemn., Conch. Cab., X, t. 161, f. 1528, 1529.
ananas, Hinds, Zool. Proc., 127, 1843.
bifasciatus, Sowb., Thes. Conch., 155, 1879.

W. C. of Africa.

105. **Murex brassica,** Lam., Anim. San. Vert., IX, 581.
rhodocheilus, King, Zool. Jour., V, 347, 1831.
ducalis, Brod. et Sowb., Zool. Journ. V, 377.

Mazatlan; Gulf of California.

106. **Murex regius,** Wood, Index. Test. Suppl., t. 5, f. 13.
taeniatus, Sowb., (young) Zool. Proc., 428, t. 49, f. 3, 1859.
tricolor, Val., Voy. Humb., II, 300.

Panama to Mazatlan.

107. **Murex bicolor,** Val., Zool. Humb., II.
regius, Schub. et Wagn., t. 230, f. 4066, 4067.
hippocastaneum, Phil., Abbild., I, t. 1, f. 2, 1845.
erythrostomus, Swains., Zool. Ill., II, 73.

Panama to Guaymas.

108. **Murex imperialis,** Swains., Zool. Ill., 2 ser., II, 67.
West Indies.

109. **Murex saxatilis,** Lam., An. San. Vert., IX, 583.
hoplites, Fischer, Jour. Conch., 236, t. 8, f. 3, 1876.
Eurystomus, Swains., Zool. Ill,, III, 101.
Ind. O.; W. C. Africa.

110. **Murex endivia,** Lam., An. San. Vert., IX, 583.
saxatilis, Linn., pars. Mörch, Yoldi Cat., p. 95.
cichoreum, Gmel., Syst. Nat., 3530.
lactuca, Bolten, Mörch, Yoldi Cat.

a. var. *saxicola*, Brod., Zool. Jour., II, 201, t. 11, f. 3
depressospinosus, Dunker, Novit. Conch., 126, t. 42, f. 3, 4.

b. var. *albicans*, Tryon, Man. Conch., II, 102.
Morrisii, Reeve, Conch. Icon., sp. 129.
Philippines.

111. **Murex coronatus,** A. Ad., Zool. Proc., 372, 1862.
Tsusaki, Japan, 35 *fms.*

112. **Murex humilis,** Brod., Zool. Proc., 176, 1832.
Sowerbyi, Kobelt, Jahrb. Mal. Gesell., 1877, IV, 248.
octogonus, Sowb., Zool. Proc., 428, t. 49. f. 7, 1859.
St. Elena, W. C. Cent. America.

113. **Murex multicrispatus,** Dunker, Novit, Conch., 125, t. 42, f. 1, 2.
crispus, Brod.. (preoccupied) Zool. Proc., 176, 1832.
tortuosus, Brod., Sowb., Conch. Ill., f. 8.
Pacasmayo, Peru.

114. **Murex melanomathos,** Gmel., Syst. Nat., 3527.
oxyacantha, Brod., Proc. Zool. Soc., 176. 1832.
Real Llejos W. C. Cent. Amer.

115. **Murex fimbriatus,** A. Ad., Zool. Proc., 71, 1853.
Gulf of California.

116. **Murex Stainforthi,** Reeve, Zool. Proc, 104, 1842; Conch. Icon., sp. 68.
hirsutus, Poirier, Novelles, Archiv du. Museum, 1882, p. 83, t. 6, f. 2a, 2b.
W. Australia.

117. **Murex angularis,** Lam., Anim. San. Vert., IX, 593.
sexcostatus, Brug., Encyc. Meth., t. 441, f. 3.
octonus, Sowb., Conch. Ill,, f. 32.

Senegal.

118. **Murex tenuis,** Sowb., Thes. Conch,, f. 174, 1879 (possibly young of *augularis*, Lam.)

Senegal.

119. **Murex lyratus,** A. Ad., Zool Proc., 269, 1851.

Cape Verde Islands.

120. **Murex fimbriatulus,** A. Ad., Zool. Proc., 375, 1862.

Japan.

121. **Murex nitidus,** Brod., Zool. Proc., 179, 1832.
melanoleuca, Mörch, Yoldi cat., 96.
nigritis, Phil., Abbild. I, t. 1. f. 1, 1845.
ambiguus, Reeve, Zool. Proc., 86, 1845.

Mazatlan.

122. **Murex radix,** Gmelin, Syst. Nat., 3527.
nigritus, Meusch., Mörch, Yoldi Cat, 96.

Panama.

123. **Murex princeps,** Brod., Zool. Proc,, 175, 1832.

W C. of Cent. Amer.

124. **Murex turbinatus,** Lam., Anim. San. Vert., IX, 586.
Formosus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 91.

Senegambia.

a. var. *spinosus*, A. Ad., Zool. Proc., 268, 1851.
turbinatus, Küster, Murex, 59, t. 23, f. 1, 2.
Küsterianus, Tapp-Can., (subfossil) Mur. Mar. Rosso., 71, t. 19, f. 1, 2, 1875.

Senegambia.

125. **Murex Beckii,** Phil., Abbild., III, t. 2, f. 1.

Habitat unknown.

126. **Murex spinicostata,** Val., Kiener, Coq. Viv., t. 41, f. 1.
fulvescens, Sowb., Conch. Ill., f. 30.
turbinatus, Sowb., Conch. Ill., f. 30.

West Indies.

127. **Murex quadrifrons,** Lam., Anim. San. Vert., IX. 586.
Bourgeoisii, Tournouer. Jour. de Conch., XXIII, p. 156, t. 5, f. 5, 1875.

West Africa.

128. **Murex Megacerus,** Sowb., Zool. Proc., 1840; Conch. Ill., f. 18.

Moquinianus, Duval., Journ. de Conch., IV, t. 5, f. 4, 1853.
castaneus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 44.

West Africa.

129. **Murex varius,** Sowb. Conch. Ill., f. 57, 108.

West Africa.

130. **Murex trunculus,** Linn., Syst. Nat., edit, XII, 1215.

asperrimus, Grateloup, Atlas, t. 30, 31.
falcatus, Sandri, Elengo, II, 48.
polygonulus, Lam., Anim., Sans. Vert., VII, 173.
subasperrimus, d'. Orb., Prodr. Pal., 175.
subtrunculus, d'. Orb., Prodr. Pal., 74.
Turonensis, Dujardin, Mem. Geol., II, 295.
Yoldi, Mörch, Sowb., Thes. Conch., f. 210, 1879

Mediterranean; Atlantic Coast of Senegal; Canary Islands

131. **Murex Zelandicus,** Quoy et Gaim., Astrol., t. 36, f. 5–7.

New Zealand.

132. **Murex Pazi,** Crosse. Journ de Conch., XVII, 183, 1869; XVIII, t. 1, f. 4, 1870.

West Indies.

133. **Murex carduus,** Brod., Zool. Proc., 175, 1832.

Paycosmayo, Peru.

134. **Murex luculentus**, Reeve, Conch. Icon., sp. 127.

fimbriatus, Hinds, Voy. Sulph., t. 1. f. 18, 19.
lamelliferus, Dunker, Mal. Blatt., XVIII, 158, 1871.

Formosa; Straits of Macassa.

135. **Murex hystricinus,** Dall, Bull. Mus. Comp. Zool., Harvard College, vol. 18, pt. 2, p. 200, t. 16, f. 4.

West Indies.

136. **Murex squameus,** Dunker, Zeit. Mal., 50, 1852.

Manilla.

Subgenus HOMALOCANTHA, Mörch.

Yoldi Cat., 95, 1852.

137. **Murex scorpio,** Linn., Syst. Nat., edit. XII, 1215.

Lamberti, Poirier, Novelles Archiv. du Museum, 1882, 86, t. 6, f. 3a, 3b.

Moluccas; Phillippines.

138. **Murex rota,** Sowb., Conch. Ill., f. 119.
Philippines; Moluccas; Red Sea.

139. **Murex secundus,** Lam., Anim. Sans Vert., IX, 568.
Philippines.

140. **Murex varicosus,** Sowb., Conch. Ill., f. 49.
digitatus, Sowb., Conch. Ill., f. 114.
Red Sea.

141. **Murex fenestratus,** Chemn., Conch. Cab., X, t. 161, f. 1536, 1537.
Phillippines; Red Sea.

Genus MURICIDEA (Swain) Mörch.

Malacol., 296, 1840.
Muricopsis, Buc. et Dautz., 1882.

1. **Muricidea cristatus,** Brocchi, Conch. foss. sub-app. 394, t. 7, f. 15,
subspinosus, A. Ad., Zool. Proc., 72, 1853.
rugulosus Costa, (juv.) Microdor, Med., 57, t. 9, f. 4, a, b, 1861.
fortis, Risso, Eur. Merid., IV, 195.
pliciferus, Bivona.
catafractus, Sowb., Conch. Ill., f. 40.
Blainvillei, Blainv., Faune franc., 139, t. 5, f. 4.
Blainvillei, Maravigua, (described ?)
Brocchii, Cantraine, (described ?)
Mediterranean; Madeira.

a. var. *Blainvillei*, Payr., Moll, Corse, 149, t. 7, f. 17, 18.
serotinus, A. Ad., Proc. Zool. Soc., 268, 1851.
porrectus, Locard, Am. Soc. Linn. Lyon, 1885, vol. 32, p. 221.
inermis, Montr., Ann. Soc. Linn. Lyon, 1885, vol. 32, p. 221.
Mediterranean.

b. var. *atterrima*, Dautzenberg, Memoirs Soc. Zool. France, Tome III, p. 166, 1890.
Dakar, Senegal.

2. **Muricidea diadema,** Aradas et Benoit, Conch. Sicil, 271, t. 5, f. 8, 1870.
Palermo, Mediterranean.

3. **Muricidea hexagonus,** Lam., Anim. Sans. Vert., IX, 585.
West Indies.

4. **Muricidea dubius,** Sowb., Conch. Ill., f. 23.
aculeatus, Wood, Ind. Test. Suppl., t. 5, f. 19.

Panama.

a. var. squamulata, Carp., Zool. Proc., 281, 1865.

Cabe St. Lucas.

5. **Muricidea pauxillus,** A. Ad., Zool. Proc., 171, 1853.

Mazatlan.

6. **Muricidea Angasi,** Tryon, Manual of Conch., II, p. 109.
scalaris, A. Ad., (preoccupied) Zool Proc., 71, 1853.

So. Australia.

7. **Muricidea octogonus,** Quoy et Gaim., Astrol., 531, t. 36, f. 8, 9.

New Zealand.

8. **Muricidea cuspidatus,** Sowb., Thes. Conch., p. 36, f. 203, 1879.

Japan.

9. **Muricidea dipsacus,** Brod., Zool. Proc., 194, 1832.
octogonus, Reeve, Conch. Icon., f. 134.
Peruvianus, Sowb., Zool. Proc., 1840; Conch. Ill., f. 103.

St. Elena, W. Columbia.

10. **Muricidea vittatus,** Brod., Zool. Proc., 176, 1832.
vitellus, Brod., Sowb., Thes Conch., f. 249, 1879.

Bay of Guayaquil.

11. **Muricidea lepidus,** Reeve, Conch. Icon., sp. 113.

Habitat unknown.

12. **Muricidea Caledonicus,** Jouss., Le Naturaliste, No. 44, p. 349; Nouvelles, Archiv. du Museum, 1882, p. 110, t. 5, f. 3a, 3b.

New Caledonia.

13. **Muricidea balteatus,** Beck, Zool. Proc., 146, 1840.

Philippines.

14. **Muricidea noduliferus,** Sowb., Zool. Proc., 147, 1840.
fruticosus, (Trophon) Gould, Bost. Proc., III, 125, 1845; Moll, Wilkes Exped., 236, f. 287.

Philippines; Upola.

15. **Muricidea euracanthus,** A. Ad., Zool. Proc., 268, 1851.
noduliferus, Reeve, Conch. Icon., sp. 150.

Habitat unknown.

16. **Muricidea rusticus,** Reeve, Zool. Proc., 108, 1845.
Habitat unknown.

17. **Muricidea interserratus,** Sowb., Thes Conch., 39, t. 31, f. 204, 1879.
Habitat unknown.

18. **Muricidea incisa,** Brod., Zool. Proc., 176, 1832.
a. var. *gemma*, Sowb., Thes., Conch., p. 32, f. 214, 1879.
W. Columbia ; California.

19. **Muricidea Floridana,** Conrad., Am. Journ. Conch., V. 106, t. 12, f. 4, 1869.
Florida.

20. **Muricidea multangula,** Philippi, (Fusus) Zeit. Mal., 25, 1848

21. **Muricidea Philippiana,** Dall, Bull. Mus. Comp. Zool. Harvard College, vol. 18, pt. 2, p. 213.

Spurious and undetermined species.

Australis, Quoy et Gaim., II, 536.
lignarius, A. Ad., Zool. Proc., 268, 1851.
pulcher, A. Ad., Zool. Proc., 270, 1851.

PROF. H. L. FAIRCHILD gave a lecture on

METHODS OF ANIMAL LOCOMOTION,

illustrated by charts and lantern views.

APRIL 13, 1890.

STATED MEETING.

Vice-President JAMES E. WHITNEY in the chair.

Thirty persons present.

The Council report recommended,
(1.) The payment of certain bills.

(2) The election of the following persons as resident members:

HON. THEODORE BACON,
MR. FREDERICK CROFOOT,
MR. HENRY C. DENSLOW,
REV. W. C. GANNETT,
DR. SUMNER HAYWARD,
MR. HENRY H. LAUDADALE,
MR. J. MOREAU SMITH,
MRS. C. H. WARD.

(3.) The election of PROF. S. A. LATTIMORE as honorary member.

(4.) The election of the following persons as curators:

MISS FLORENCE BECKWITH, in Botany.
REV. JOHN WALTON, in Conchology.
MR. GEORGE H ASHLEY, in Geology.
PROF. CHARLES W. DODGE, in Biology.

The bills were ordered paid, and the candidates elected by formal ballot.

The following amendment to the By-Laws, proposed March 9, 189·, was adopted:

Resolved, That Section 1, of Chapter XIII, of the By-Laws, be stricken out; and that in Section 1, Chapter 1, of the By-Laws the words "initiation fee" be stricken out, and the words "first annual dues" inserted instead.

DR. CHARLES FORBES read a paper on

PROPERTIES OF LIGHT IN THEIR RELATION TO ORTHO-CHROMATIC PHOTOGRAPHY.

Illustrated by photographs and diagrams.

The following paper was read:

NOTICE OF A NEW METEORITE FROM LOUISA CO., VA.

BY EDWIN E. HOWELL.

If the subject of the present sketch is a distinct "fall," it makes the eighth reported from the State of Virginia.

The first fell in Chesterfield County, June 4, 1828, and is the only one of the eight seen to fall. Both the Grayson County and the Roanoke County were found in 1842 and the Botetourt County in 1850.

Of the Augusta County meteorite five distinct pieces have been found, the largest weighing 152 pounds, being found in 1858 or 1859.

This came into possession of Ward & Howell in 1876, and was cut into sections and distributed to the various collections of meteorites throughout the world. The other pieces weighed as follows: 56 pounds, 36 pounds, 3.5 pounds, 2.2 pounds. This last and smallest piece was found in 1887. Since the finding of the Louisa County meteorite two other meteorites have been reported, one from Henry County, the other from Pulaski County.

The Louisa County meteorite was found on or about March 3rd, 1886, by Mr. Fred. H. Crofoot, while prospecting for gold in the bed of a small stream in the vicinity of the Old Louisa Gold mine, about three miles south-east of Tolersville, Louisa County, Virginia. The total find consists of only a small fragment, less than ¼ oz. in weight. It is an octahedral iron, so much decomposed that the tænite, kamacite, and plessite are easily seperable. What there is of it so clearly resembles the Augusta County meteorite in structure that one is forced to suspect that it may be identical; the only argument against it being the distance—50 to 75 miles—from where the other Augusta County fragments have been found. This is not an insuperable objection, but as all the largest pieces have been found within a radius of a few miles it seems preferable to consider this a distinct fall, to be known as the Louisa County Meteorite.

Mr. Howell exhibited several sections of other meteorites.

APRIL 27, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD in the chair.

A large audience present.

The second lecture of the Popular Lecture Course was given by Mr. E. E. HOWELL, on

GEOLOGICAL EXPLORATIONS OF OUR WESTERN COUNTRY.

Illustrated by relief maps, charts and lantern views.

MAY 11, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Thirty persons present.

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

The third paper on the printed programme was given precedence, and was read by MR. CHARLES W. DODGE, entitled :

ON JEFFERSONIA DIPHYLLA, AND ITS OCCURRENCE NEAR ROCHESTER.

(*Abstract.*)

This plant is usually regarded as one of rather local habits and botanists regard it as quite a "find" when they discover one. So far as I am able to learn it is quite rare in the immediate vicinity of Rochester, hence, the discovery of a small colony of plants in a patch of woods near Pittsford by Shelly G. Crump, Esq., is of considerable interest. The colony originally consisted of about fifty plants, all growing within a radius of about one hundred feet, a fact which would point to their all being descendants of a single plant. Mr. Crump is thoroughly familiar with all of the woods around Pittsford, but has never found *Jeffersonia* until this spring, although the particular piece of woods in which it was found has been his favorite collecting ground for several years.

Aside from its rarity *Jeffersonia* is interesting for several features: its sepals fall off as the petals expand, a rather uncommon occurrence among flowers ; its anthers open by valves, which open upwards like trap-doors, swinging out sidewise from the top of the anther ; the seed-pod is a pyxis, the top being hinged to the bottom and opening upward, the hinge extending about one-fourth of the way around the pod ; the leaf is parted into two leaflets, which fact has given the plant the common name of Twin-leaf, and likewise its specific name, *diphylla*; further, the name, *Jeffersonia*, which was given it in honor of Thomas Jefferson, whose scientific achievements are almost entirely unknown to the present generation, furnishes the almost solitary instance in which any of our statesmen have been commemorated by having their name given to a newly discovered plant or animal.

Mr. Dodge exhibited a growing specimen and also herbarium specimens.

MR. GEORGE H. ASHLEY gave

A REVIEW OF GILBERT'S "LAKE BONNEVILLE"

The speaker opened by calling attention to the fascination which attaches to the development of such a story as that of Lake Bonneville.

Following the definition and brief description of inland basins, and of our Great Basin, was given an outline history of the discovery, exploration and development of this region by Capt. Bonneville and Fremont on the Great Basin, and on Lake Bonneville, from Standsbury, who first noticed the shore lines, to Howell and Gilbert, the latter of whom named as well as described the lake. Lake Bonneville was a great inland sea, deeper, though smaller, than Lake Superior, and occupying a large part of western Utah. Existing in post-Pliocene times it has left to-day striking shore lines, great deltas, benches, etc. The story of the lake, as developed by Mr. Gilbert, is briefly as follows:

The region was long a dry one. A change in atmospheric conditions, the causes for which were discussed, resulted in a slow and unsteady but gradual rise of accumulating water until it was 1,000 feet deep, and covered an area of 40,000 square miles. A long period of rest followed, when the previous conditions returned and the waters subsided.

After a long period under the arid conditions the disturbing causes reappeared, and again the lake rose, with frequent pauses, which produced numerous shore lines. Rising 70 feet above the first high water mark it overflowed a great alluvial deposit in a pass to the north. It rapidly cut its way 475 feet through the deposit to rock bottom, forming a mighty river to the Columbia, and lowering the lake the same distance. A long stand at this point resulted in what Mr. Howell called the Provo shore-line, characterized by its great deltas and beaches.

After standing a time, estimated at five times the wait at the Bonneville shore line, a return of pre-existing conditions caused the waters to subside, with a number of stops, the principal one being the Standsbury, half-way down to the present level of Great Salt Lake.

Faulting, glacial and volcanic action, were discussed in their relation to the history of Lake Bonneville, and the speaker ended with a history of some interesting changes that have taken place in that region in the last quarter century.

The paper was illustrated by a map.

MR. H. L. PRESTON read a paper on

ECONOMIC MINERALS OF THE ANCIENTS.

JUNE 1, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

A large audience present.

MR. ADELBERT CRONISE gave the third lecture of the Popular Lecture Course, on

RUSSIA: FINLAND, ST. PETERSBURG, MOSCOW, EASTERN RUSSIA AND THE CRIMEA.

Illustrated by maps and lantern views.

JUNE 8, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

Forty-four persons present.

The Council report recommended:

(1.) The appropriation of certain sums of money towards payment of printing the Proceedings, etc.

(2.) The election of the following candidates:

MISS GERTRUDE C. BLACKALL,
DR. S. H. LYNN,
MR. GEORGE MOSS.

The appropriations were voted, and the candidates elected by formal ballot.

The following paper was read :

ANALYSES OF KAMACITE, TÆNITE AND PLESSITE FROM THE WELLAND METEORIC IRON.

BY JOHN M. DAVISON.

The siderolite which is the subject of this paper is described by Edwin E. Howell on pages 86–87 of the proceedings of this Society for 1890. Its analysis gave Fe. 91.17 and Ni. 8.54 It is singularly free from troilite and schreibersite, and thus offered an unusually good opportunity for the analysis of its separated nickel-iron alloys.

On sawing the meteorite the outside was found much decomposed; but between this and the compact center was a zone in which the oxidation was superficial, and confined, for the most part, to planes of contact of the different nickel-iron alloys that form the Widmanstätten figures. It thus became possible to separate the kamacite and tænite in quantities sufficient for analysis.

The quantity of kamacite used for analysis was gm. 0.934 ; of tænite gm. 0.4522.

The physical character of these alloys differ widely. The kamacite is brittle, breaking with a subconchoidal fracture, and is of the color of cast iron. It was coated with a thin film of black oxide, which had often a resinous luster as if covered with lacquer, particularly where the tænite had been freshly stripped off. This oxide was attracted by the magnet and is probably the magnetic oxide Fe_3O_4 Some pieces of kamacite of a millimeter or two in thickness were entirely altered to this oxide. The kamacite shows, in places, a corrugated surface in some specimens resembling bundles of rods, like the columnar structure of hematite. Figures 1 and 2, Plate 14, show this columnar structure. In the latter the tænite which closely followed the form of the kamacite, is laid back but not detached.

The tænite has a silvery luster, with, when slightly oxidized, a tinge of bronze. It is flexible and elastic, and fuses on the edges in the oxidizing flame of the blowpipe, turning dark. Its fusibility seems to be about 5. It resists oxidation better than the kamacite, the contrast between its comparatively fresh appearance and the dark film covering the other was marked, and facilitated their separation.

Both kamacite and tænite were magnetic, and exhibited a weak polarity, which was more marked in the latter. Pieces of tænite floated directly on water, and pieces of kamacite, buoyed on a cork, arranged themselves in the magnetic meridian : the tænite promptly, the kamacite after being left for some time protected from air currents under a bell glass. The meteorite as a mass also showed polarity. The tænite is found separating the plates of kamacite, and enveloping the crystals of plessite. Figures 3 and 4 show plates of kamacite which were in close contact, and when separated were found to have been joined by a little triangular prism of the same substance. It is attached to 4, and has penetrated 3 to the depth of 1.5 m.m The socket in 3 was lined with tænite. It was at first intended to analyze the plessite as a whole; but on examination, its fine layers were so suggestive of alternate lamellæ of kamacite and tænite that the attempt was made to separate them, and to analyze each separately.

It was found that one was brittle, the other flexible and elastic; one dark with superficial oxidation, the other showing the tænite luster. Physically their correspondence, the one with kamacite, the other with tænite, was exact, and in the kamacite-like part the columnar structure was shown on a diminutive scale, the diameter of the rods being from $\frac{1}{6}$–$\frac{1}{3}$ m. m.

Their separation then became simply a matter of patience, and with the aid of a watchmaker's glass and a magnetized needle, to pick up the grains and flakes, most of which were too small for even delicate forceps to handle, there was obtained for analysis, of the part resembling kamacite, gm. 0.5261, of that resembling tænite, gm. 0.1314.

The thickness of the kamacite was from 1–2 m.m., that of the tænite from $\frac{1}{15}$ to $\frac{1}{30}$ m.m.

In the plessite the kamacite-like bands were from $\frac{17}{30}$ to $\frac{1}{30}$ m.m thick; the tænite-like bands, as nearly as could be measured, from $\frac{1}{130}$ to $\frac{1}{220}$ m.m.

The method of analysis was the same in each case. The material was gone over repeatedly, piece by piece, with a watchmaker's glass, and very carefully assorted and cleansed, the pieces of kamacite being scraped bright. It was not possible to do this to any extent with the kamacite-like part of plessite. It was dissolved in dilute hydrochloric acid by the aid of a weak galvanic current at the positive pole of the battery.

The carbon thus separated was collected on a Gooch filter and burned. The nickel and cobalt were separated from the iron by digestion in ammonium hydrate, the process being repeated four times. The iron was weighed, and the nickel and cobalt first determined together by electrolysis, then separated by potassium nitrite and each determined separately in the same manner.

For comparison the analyses of kamacite and tænite are given, each next to its corresponding part of the plessite.

	Kamacite.	Plessite.		Tænite.
		Kamacite-like part.	Tænite-like part.	
Fe	93.09	92.81	72.98	74.78
Ni	6.69	6.97	25.87	24.32
Co	.25	.19	.83	.33
C	.02	.19	.91	.50
	100.05	100 16	100.59	99.93

These physical and chemical correspondences justify, I think, the conclusion that in the Welland siderolite there are but two distinct nickel-iron alloys, viz.: kamacite and tænite, and that the so-called plessite is merely thin alternating lamellæ of kamacite and tænite.

It is unsafe to generalize on a single analysis; but an examination of the markings of other meteoric irons suggests the thought that in them also there may be but two distinct alloys. Such are the Descubridora, the Glorietta Mt. and notably the Kiowa County, and the Augusta County, Va. meteorites. In sections of the last two irons in Ward & Howell's collection every piece of so-called plessite in the Augusta County iron shows its thin lamellæ, and in the Kiowa County pallasite the gradations of the markings are such that in parts of the iron it would be difficult to say which should be called kamacite and which plessite.

In etching meteoric iron the kamacite is attached by acid more readily than the tænite, richer in nickel. The tænite and plessite stand in relief. Where lamellæ do not show in plessite it may be that closely crowded tænite bands have protected neighboring kamacite layers from acid action, and more careful or prolonged etching might perhaps develop lines in plessite that now appears homogeneous.

Remarks upon the paper were made by Mr. E. E. Howell and the President.

In the absence of the author, Mr. J. G. D'Olier read the following paper.

PLATE 14.

Figs. 1 and 2. Kamacite, showing columnar structure. 2 also shows the tænite, which had followed the corrugations, laid back, but not detached.

Figs. 3 and 4. Kamacite with triangular prism of same on 4, penetrating 3 to depth of 1½ m.m.

Fig. 5. Tænite enclosing decomposed kamacite; half of upper plate of tænite (toward smaller end) removed.

The other figures are plessite crystals.

The figures are all magnified two diameters.

× 2 diam.

DAVISON—WELLAND METEORITE.

NOTE UPON ABORIGINAL IMPLEMENTS RECENTLY FOUND IN IRONDEQUOIT.

BY GEORGE H. HARRIS.

(*Abstract.*)

This paper described a recent discovery in Irondequoit, of aboriginal relics consisting of war club heads, lead bullet, brass finger ring, 150 knife blades of flint, stone arrow finisher, and a quantity of war paint. The lead and rings are memorials of the early use of fire arms by the Indians, and of the christian labors of the Jesuit fathers in the ancient Seneca territory. The flint blades and paint were found in *cache*, and doubtless constituted the stock in trade of some stone worker of the first half of the 17th century. The find was exhibited, and the method of mounting stone implements illustrated by several articles shown. In this connection the speaker mentioned the marked distinction existing in certain forms of stone relics, assigning each to a special class.

The following paper was presented :

GEOLOGICAL DATA OF THE OTIS AND GORSLINE WELL.

BY H. L. FAIRCHILD AND E. E. HOWELL.

The samples of rock-borings from the well were exhibited and discussed. The results are embodied in a paper to be found on a subsequent page.

JUNE 22, 1891.

STATED MEETING.

The President, PROF. H. L. FAIRCHILD, in the chair.

A large audience present.

MR. G. K. GILBERT gave the fourth lecture of the Popular Lecture Course, entitled :

THE GREAT BASIN.

The lecture was illustrated by charts.

The following paper was read by title :

A SECTION OF THE STRATA AT ROCHESTER, N. Y., AS SHOWN BY A DEEP BORING.

BY HERMAN LEROY FAIRCHILD.

By means of the drill an examination has lately been made of the rocks beneath the city of Rochester, with results of some geologic interest. In the faint hope of obtaining gas from the Trenton limestone, or other horizon, the firm of Otis and Gorsline have bored to a depth of over three thousand feet. These gentlemen were impelled to this test, partly by the objections made to the smoke from the large quantity of soft coal required in the burning of their sewer pipe, and partly from a commendable spirit of enterprise and investigation. Their hope was based upon the gas-yielding character of the Trenton limestone of other, though distant, localities, and the fact that only seventy miles away, at Buffalo, the firm's establishment was supplied with natural gas from Canada. Although the search was declared quite hopeless, no one could say it was impossible that gas should be found at some horizon, perhaps under new and unexpected conditions.*

Despite probable failure, and the large outlay of money required, Messrs. Otis & Gorsline showed an admirable perseverance. The boring began Dec. 2, 1890, and stopped March 13, 1891. The drill was sent to a depth *in the rock* of 3,078 feet, where the exceeding hardness of the rock made further progress very difficult. Small but evanescent quantities of gas were found at various depths, the greatest at the depth of 378 feet. A little brine was encountered at a depth of 1330 feet. The only valuable result of the boring is the addition to geological science, in our knowledge of the buried rocks as detailed below. The desire to express appreciation of the enterprise and public spirit which gave us this knowledge is the writer's apology for this preface.

At the beginning of the work the Geological Section of the Rochester Academy of Science appointed a special committee upon the well, consisting of the chairman, Mr. E. E. Howell, and the writer. It was impossible for either member of the committee to personally watch the drill and collect samples. It was consequently left to the drillers, who are believed to have been trustworthy, and were certainly willing and accommodating. They were asked to save samples of the rock for every fifty feet, and as often as the rock perceptibly changed in character.

*In a lecture before the Rochester Chamber of Commerce, Dec. 19, 1890, the writer, by invitation, discussed the subject of rock gas and the conditions necessary for its accumulation.

These directions were followed, after the first samples, as carefully, it is believed, as could conveniently be done by the drillers. There is, of course, a range of error of a few feet. The record obtained is of special value because the section includes all the strata from the Niagara to the Calciferous or, possibly, to the Archæan ; because of the care with which it was made; and also because samples of the boring will be preserved in the Museum of the University of Rochester, and duplicates in the National Museum at Washington, and in the museum of Cornell University.

In the neighboring ravine of the Genesee, about one mile distant from the well, the strata of the Niagara Period are shown as far down as one hundred feet into the red Medina, which enables us to check off the first few measurements of the well record. The first sample was taken at the top of the rock-section, in the Niagara limestone, and covers 156 feet, the second sample being taken 156 feet lower and representing the upper Clinton shale.

The following table shows the correspondence between the exposed strata and the first part of the record.

Well Record.			Thickness shown in Genesee Ravine.
Sample.	Strata.	Thickness.	
	Drift.	22 feet.	
1	Niagara limestone.	156 feet.	60 feet+—
	Niagara shale.		80 "
	Clinton limestone.		18 "
2	Clinton upper green shale.	22 "	24 "
3	Clinton (Pentamerous) limestone.	15 "	14 "
4	Clinton lower green shale.	35 "	24 "
	Medina gray band.	(not noted)	5 "
5	Red Medina sandstone.	+	+

The discrepancy shown above in the measurement of the Lower Clinton shale may be due to counting in the top of the Medina, or, possibly to a thickening of the shale in the direction of the well. The whole table indicates more accurate observation and measurement than is usual in well records.

Following is the

CONDENSED SECTION OF THE ROCHESTER WELL.

Altitude, 484 feet above tide.

HORIZON.	THICKNESS.	KIND OF ROCK.	DEPTH.
Niagara,	156 ft.	Niagara limestone, Niagara shale, Clinton limestone, sample 1.	156 ft.
Clinton,	22 "	Clinton upper green shale, sample 2.	
	15 "	Clinton (Pentam.) limestone, sample 3.	
	35 "	Clinton lower green shale, sample 4.	228"
Red Medina,	1075 "	Red sandstones and shales, samples 5-21.	1303"
Oneida, (Oswego)	25 "	Blue shaly sandstone, sample 22.	
	45 "	Hard gray sandstone, sample 23.	
	13 "	Dark gray shaly sandstone, sample 24.	1386"
Hudson & Utica	598 "	Dark shales, samples 25–37.	1984"
Trenton,	954 "	Dark limestone, samples 38–57.	2938"
Calciferous ?	10 "	Gray limestone, sample 58.	
	30 "	Drab limestone, sample 59.	
	50 "	Dark gray limestone, with shale, sample 60.	
	44 "	Black magnesian limestone, sample 61.	
	3 "	Dark calcareous shale, sample 62.	3075"
Algonkian ? or Archæan ?	2 "	White quartz sandstone, sample 63.	
	1 "	Powdered ferruginous quartz, sample 64.	3078"
	3078 "		

As three sets of the borings will be deposited in institutions, it is unnecessary to go into detailed description of all the rock samples.

Down to sample 57 there is no chance for any doubt. The limits of the Medina, Hudson and Trenton are very sharp.

The last samples of the Hudson–Utica are considerably darker than the earlier samples, but no separation can be made.

Samples 56 and 57, making 60 feet, are pure drab-colored limestone. Indeed, 160 feet of the bottom of the Trenton, samples 54–57, are drab-colored, with "birds-eye" structure, and are regarded by the writer as representing the Birdseye and Chazy limestones. Mr.

Howell, however, was inclined to regard these as proper Trenton, and considered that which I have marked Calciferous as partly Birdseye and Chazy.

The last two samples are the most doubtful. The drillers declare that they worked thirty-six hours to cut the short distance represented by the last sample, and that the resistance of the rock surpassed any previous experience. This sample is a very fine ferruginous quartz, mostly angular fragments, and represents either a crushed red sandrock, a siliceous conglomerate or a ferruginous quartzite. The small proportion of rounded grains might, perhaps, have been derived from the stratum above, sample 63. The fineness of the material would indicate that the rock was of extreme hardness, and that the drill expended its energy in pulverizing the material, like a pestle in a mortar, instead of penetrating the rock. It is doubtful if any rock except metamorphic would so resist the drill. No material except quartz has been observed after careful study. Other minerals might have been removed by the water. The iron color seems to be largely superficial.

The probability of this representing the Archæan or the Algonkian is reasonable, as at the nearest exposures the Calciferous lies directly upon crystalline rock.

By aid of published and manuscript records, chiefly of Mr. C. S. Prosser,[1] it is possible to make some interesting comparisons of the thickness of the rocks in this and near localities. Sections to the westward are available from St. Catharines, Canada, eighty-two miles from Rochester, and Gasport, N. Y., fifty miles from Rochester; to the eastward, from Clyde, forty-two miles from Rochester, and Wolcott, a few miles northeast of Clyde.

Thickness of Medina.

Red Medina alone.

St. Catharines.[2]	Gasport.[3]	Rochester.	Wolcott.	Clyde.
850	———	1075	690	942

Medina, including the transition strata Oneida or Oswego.

St. Catharines.	Gasport.	Rochester.	Wolcott.	Clyde.
850	1056	1158	1070	1034

Thickness of Hudson and Utica.

St. Catharines.	Gasport.	Rochester.	Wolcott.
785	640	598	650

1. *The thickness of the Devonian and Silurian rocks of Western Central New York*, by Charles S. Prosser, in American Geologist, Vol. 6, October, 1890.

2. Ashburner, in Trans. Am. Inst. of Min., Engrs., Vol. XVIII., 1890, p. 300.

3. For the record of the Gasport well the writer is indebted to Mr. Prosser, also to Mr. C. V. Messler of Gasport.

THICKNESS OF TRENTON.[4]

St. Catharines.	Rochester.	Wolcott.
677	954	750 + 850 (?)

THICKNESS FROM THE TOP OF THE MEDINA TO THE TOP OF THE TRENTON.

St. Catharines.	Gasport.	Rochester.	Wolcott.
1635	1696	1756	1720

THICKNESS FROM THE TOP OF THE MEDINA TO THE BOTTOM OF THE TRENTON.

St. Catharines.	Rochester.
2312	2710

The following paper was read by title :

A LIST OF THE INDIGENOUS FERNS OF THE VICINITY OF ROCHESTER, WITH NOTES.

BY C. W. SEELYE.

Ferns are properly mentioned as shade-loving plants. But with some species, at least, it is evident that the conditions they seek and require are those which are attendant upon shady places rather than the shelter from the sun ; it is the moist atmosphere and the cool soil which are favorable to their existence, not merely the exclusion of more or less sunlight. The shaded sides of rocky banks, the banks of streams, bays and lakes, open or thin woods with undergrowth, the bases of railway embankments facing the north and north-east, rich and moist grounds which have been cleared from the forest and afterwards allowed to grow up to small trees, shrubs and underbrush, all these are favorable situations for the growth of ferns.

In many places some species of ferns will be found growing where they are quite exposed to the sun, but the conditions in such cases are always favorable to a more or less moist atmosphere and a comparatively cool soil. As an instance of this kind may be noticed a certain locality which was under the observation of the writer for several

4. The term "Trenton" is here intended to include all the strata from the Hudson-Utica to the Calciferous.

seasons. It was at the lake shore, near Charlotte, west of the river and where formerly a broad beach of fine sand extended back to a piece of low and swampy ground, where grew coarse grasses and other herbs and a few shrubs. Along the border of this ground, amid the grasses, grew *Onoclea sensibilis* in great abundance; but the ferns did not confine themselves to the shade supplied by the other plants; they extended out into the sand twenty to thirty feet or more distant from any shade whatever, and apparently flourished as well. The cause of this was that the soakage from the swamp kept the sand under the surface constantly damp, thus providing the roots of the ferns with an unfailing supply of moisture.

Another example illustrating the point under consideration may be given. The Common Polypody, *Polypodium Vulgare*, L. is not common in this region. Wherever found here it is in close proximity to water and in shade. The plant seldom assumes ample proportions in this region. In striking contrast to it, as it appears here, is it found in the northern part of this State, and especially along the banks of the St. Lawrence. Among the Thousand Islands it may be seen springing from the crevices and pockets of bare rocks, fully exposed along the water's edge, disdaining all shelter from summer's sun and winter's winds and storms. And in that vicinity, on the main land, on the Canadian side, not only near the river but for miles back, the writer has seen it growing over rocks in solid masses, covering many square yards of surface, and without any shade unless it may have been that afforded by some distant tree-top which intercepted the slanting rays of the rising or the setting sun. In all the northern region of our neighboring dominion, with comparatively few days of hot sunshine, and an atmosphere that is profoundly modified by the currents of air moving down from the Arctic Ocean and passing over its chains of lakes and rivers, and over that great inland sea, Hudson's Bay, and over the great lakes, there is an atmospheric condition admirably adapted to the welfare of the plant mentioned, and it flourishes in great vigor all through that region. The botanical collector of our own neighborhood might wonder, as did the writer in his early study of the ferns, why a plant which is so seldom found here, as is *Polypodium vulgare*, should bear the specific name which it does. The author of this name, it may be noted, was Linnæus. Undoubtedly he may have received specimens of the plant from many sources and so recognized its wide range; but the appropriateness of the name was apparent to him chiefly, it may be presumed, because in his native land the plant grows abundantly. The great peninsula comprising Norway and Sweden having its northern shores swept by the waves of the polar ocean, its western boundary by the Atlantic, its southern by the North and the Baltic seas, and its eastern by a great gulf, has an atmosphere and a general temperature well adapted to the wants of the plant, and it grows throughout that region, even extending within the arctic circle.

The condition of humidity is the one of prime importance to this species; it can maintain itself in a warm climate if shaded from a bright sun and near the water. So, in its southern localities it grows in hilly and mountainous regions traversed by streams and in other places where its necessary conditions are met. Hooker, in *"British Ferns," says it "is found in the cold and temperate regions of the globe; throughout Europe to its extreme south; North Africa, Madeira, the Canaries, and Azores. In Siberia we possess specimens from the Amur, from Manchouria, and from Japan, from Erzeroum; but in the more tropical parts of Asia it seems unknown, even in the great Himalayan range, which exhibits so many European forms. In North America, in the United States and Canada, and in the Hudson's Bay territories, it is frequent. East of the Rocky Mountains, and in California, whence I have seen it only from Benicia, (A. B. Eaton, U. S. Army), the fronds are larger, much acuminated, yet not universally so. South of California, on the great continent of America, I am not prepared to say it exists. Eaton, in †"Ferns of North America," says: "The North American range extends from the Atlantic to the Pacific, and from the Slave River and Winnipeg Valley to the mountains of Colorado, Arkansas and North Carolina, and probably to those of Alabama also. * * * Throughout Europe and Northern Asia to Kamtschatka and Japan; Azores, Madeira, Barbarv States, and Cape Colony. Mexico and the Hawaiian Islands are also mentioned by some authors; but the evidence is not satisfactory." A climate like that of Great Britain, with its humid atmosphere, might be supposed, as it really is, well adapted to the wants of this plant. Hooker says of it: ‡"Common throughout England, Scotland and Ireland, on old banks, walls, rocks, mossy trunks of trees, etc." And George W. Johnson, another English author, says: §"This species is common throughout the British Islands on old walls, old roofs of cottages, shady banks, and trunks of old trees." It is not found in Florida. Chapman mentions, for the Southern States, ‖"Mossy rocks, etc., in shady woods, in the upper districts of Alabama, and northward." These references are sufficient in evidence that this plant disappears in the hot and arid regions and delights in coolness and humidity; and with

*Hooker, British Ferns, t. 2.

†Eaton, Ferns of North America, Vol. 1, p. 238.

‡Hooker, British Ferns, t. 2.

§Johnson, British Ferns, p. 228.

‖Chapman, Flora of the Southern United States, 2d Ed., p. 588.

these facts in mind we can satisfactorily account for the paucity of the plant in our own vicinity, which, though not lacking an atmosphere comparatively moist, yet has few localities well sheltered from the sun whose fervent summer rays are felt for a long term; where favorable spots exist here, close to a body of water, the common Polypody is sometimes found.

Shirley Hibbard, an English horticulturist, remarks in relation to this plant: *"None of our native ferns endure drought so well as this." In view of what has been written above, this statement would seem at least doubtful to one not well acquainted with the habits of the plant. Yet it is true that when once established it will persist in localities which are apparently very unpropitious, such as on the brink of cliffs, nestled beneath the exposed root of some tree or shrub and where all about, outside of shade, the sun for half the day strikes with great power. In such places the fronds for many days in summer will partially roll up and wither and seem to be dying, but with the return of the cooler season and plentiful rains, will straighten out and resume a normal appearance. In these circumstances, however, the plants never exhibit exuberant growth. When the plant has become established in a spot where its existence is something of a struggle it is enabled to endure a long season of drought by means of the nutriment stored up in its somewhat fleshy rhizome. The mode of root growth of *Polypodium vulgare*, is the cause of its shrinking from the sun in unfavorable locations. It sends down no strong roots, but from the rhizome spread out laterally some rootlets, almost hair-like, into the light vegetable mould on the surface or in the crevices of rocks from which alone it gathers its nourishment. As has been noticed in the case of the *Onoclea*, which can stand a full exposure to the sun when its roots are constantly supplied with moisture, so this Polypody when surrounded by conditions which enable it easily to conserve its moisture can bear the full sunshine on the face of a rock. One other example in illustration of the same point may be given. *Aspidium marginale*, Swartz, in this region, grows only in the shade, but in the Canadian locality which has been mentioned, it grows freely in the open fields, and next to the common Polybody is the fern most frequently found in that region. Both Gray and Eaton give the habitat of this fern as "rocky hillsides in rich woods," and the definition is correct for most parts of the United States; in the Dominion of Canada, however, it is different, and it was a pleasure to have my own observation on this point confirmed by Dr. Lawson, of Dalhousie University, when a copy of his †Fern Flora of Canada was received last year. In

* Shirley Hibbard, The Fern Garden, 4th Ed., p. 84.
† Lawson, Fern Flora of Canada, p. 242.

that manual the habitat of the Marginal Shield Fern is described as "Rocky banks in shady and exposed places, the large rhizome enabling this species to resist the heat and drought of summer." That description is correct for the most of Canada, while the descriptions of Gray and Eaton are proper for the most part of this country. In regard to these two ferns, and in relation to their power to bear sun exposure, the two localities mentioned are on the opposite sides of a dividing line, and their climatic conditions are nicely indicated by the behavior of these plants in each region.

The territory about Rochester, taking in Monroe and adjoining counties, presents a considerable variety of surface; generally it is slightly rolling, but in a few places rises to a height of three hundred to five hundred feet. There are some swamps of considerable extent. The Genesee river and numerous creeks and small streams intersect the land, and from Lake Ontario a number of deep bays extend inward; ponds and small lakes add to the diversity. Ravines and gullies traverse the hilly sides of the bays, lakes and water courses. The rougher and broken portions of the land are mostly covered with timber or a growth of shrubs and smaller plants in a state of nature. A region of this character possesses the requisite conditions for a suitable home for many species of ferns, and, as may be seen by the list herewith, the fern flora is well represented in the vicinity of Rochester.

The complete list of the Ferns of New York, as given in the Bulletin of the Torrey Botanical Club,* comprises fifty-three species and varieties; forty-six in the order Filices or true ferns, and seven in Ophioglossaceæ. Of these there are found in this vicinity thirty-five species and varieties, and, also, two varieties of *Cystopteris* not contained in that list.

The species lacking in our flora, eighteen in number, and which are found in some other portions of the State, are the following:

Cheilanthes vestita, Swartz.
Pellæa gracilis, Hooker.
P. atropurpurea, Link.
Woodwardia angustifolia, Smith.
Asplenium montanum, Michaux.
A. Ruta-muraria, Linnæus.
Scolopendrium vulgare, Smith.
Phegopteris polypodioides, Fée.
Aspidium fragrans, Swartz.
A. Boottii, Tuckerman.

* Bulletin Torrey Botanical Club, vol. vi., p. 268.

A. aculeatum, var. Braunii, Koch.
Woodsia obtusa, Torrey.
W. Ilvensis, R. Brown.
W. hyperborea, R. Brown.
W. glabella, R. Brown.
Lygodium palmatum, Swartz.
Botrychium simplex, Hitchcock.
B. Lunaria, Swartz.

An examination in detail of the above list will show that some of the species are rare in the whole country, some rare in the State for the reason that their range is either farther south or west, or farther north. *Cheilanthes vestita*, Swartz, has only been found in this State in one spot, on Manhattan Island. Its range is farther south. *Pellæa gracilis*, Hook, and *P. atropurpurea*, Link, are rare both in the State and elsewhere in the country. *Woodwardia angustifolia*, Smith, is never found far from the Atlantic coast. *Asplenium montanum*, Mchx., has been found in this State only in Ulster County. *A. Ruta-muraria*, L., is a scarce species in the State. *Scolopendrium vulgare*, Smith, is known in this State only at a few stations in Onondaga and Madison Counties. *Phegopteris polypodioides*, Fée, is found only in the northern and mountainous parts of the State. *Aspidium fragrans*, Swartz, has been found in this State only at Lake Avalanche in the Adirondac mountains. *A. Boottii*, Tuck., occurs in the southern and central part of the State. *A. aculeatum*, var. *Braunii*, Koch, belongs to the north, as do also the *Woodsias*. *Lygodium palmatum*, Swartz, is a local species, being found in this State only in Greene County, and possibly one other station. *Botrychium simplex*, Hitch., and *B. Lunaria*, Swartz, are both rare in the State, only a few stations for them being known.

With the exception, therefore, of the very rare species and those with which our latitude is out of range, the locality of Rochester shows a complement of the species belonging to the State. A few of these species are rarely found here, even careful collectors not having met them; and this inspires the hope that some species not yet known to the locality may yet be discovered by future explorers.

In addition, the writer has to say that the list has been formed by comparing and combining with his own the records of the following named persons, who have kindly supplied them for the purpose: Dr. Anna H. Searing, Mr. George T. Fish and Mr. Joseph B. Fuller, all of this city. Each of the records contains one or more species not in the others, and it is believed that the list as now offered is nearly or quite complete to this date. The species belonging to the State but which are absent in our flora are given in their respective places in the list in italics, thus showing at a glance a comparison of the species of the State and those of this vicinity. Gray's Manual of Botany, Sixth Edition, has been closely adhered to in the sequence of genera and species, the nomenclature, and the authorities.

ORDER, FILICES.

Polypodium, Linnæus. POLYPODY.

1. **P. vulgare,** Linnæus. This little evergreen fern is rare in this region, being found only near water and in the shade, on rocks, and roots of trees. The most favored locality in the near neighborhood of Rochester is the east side of Irondequoit Bay, near the sand bar, in the shade, close to the bank. George T. Fish reports it on the west bank of the Genesee river without being more explicit ; probably somewhere between the city and Charlotte. Professor Lennon, of Brockport, mentions finding it in a ravine at Holley, Orleans County, twenty miles west of the city. It is sparsely scattered along the cliffs, in the shade, on the eastern shore of Canandaigua Lake.

Adiantum, Linnæus. MAIDENHAIR.

2. **A. pedatum,** Linnæus. One of the most graceful of all the numerous species of the Maidenhair fern. Common in rich and moist shady woods and on shady banks. Very generally distributed throughout this region.

Pteris, Linnæus. BRAKE, OR BRACKEN.

3. **P aquilina,** Linnæus. Very commonly distributed in partially shaded places and hillsides and old, cleared, but uncultivated grounds, and shaded roadsides.

Cheilanthes, Swartz. LIP FERN.

4. **C. vestita*, Swartz. Absent.

Pellæa, Link. CLIFF BRAKE.

5. *P. gracilis*, Hooker. Absent.
6. *P. atropurpurea*, Link. Absent.

Woodwardia, Smith. CHAIN FERN.

7. **W. Virginica,** Smith. A rare species in this region. The writer has never seen it growing here. Reported by George T. Fish and Joseph B. Fuller at the Mendon ponds.

8. *W. angustifolia*, Smith. Absent.

*The species, the names of which are printed in italics, are absent from this vicinity, but are found at some other points in the State of New York.

Asplenium, Linnæus. SPLEENWORT.

9. **A. Trichomanes,** Linnæus. Fish mentions as a station for this rare fern, "near Irondequoit Bay, east of the Float Bridge." Fuller says, "same ravine as *Camptosorus*." Prof. Lennon found it in the ravine at Holley. It grows somewhat freely on the rocky walls of Watkins' Glen.

10. **A. ebeneum,** Aiton. The writer discovered a single plant of this species in the summer of 1882, near the "Sea Breeze," on the grounds of the summer resort of F. S. Rew. A natural growth of trees remains on the place, and under one of the trees was growing this Black-stalked Spleenwort. As it was known to be rare here the spot was carefully noted, and the following year another visit was made to see it and it was found to be there as previously. The third summer the place was again visited, and, although the spot being well known was found, there was no trace of the cherished plant. It is believed that this is the only specimen of the species ever seen very close to Rochester, and the only other reported is in the ravine at Holley, collected by Professor Lennon.

11. *A. montanum*, Wildenow. Absent.

12. *A. Ruta-muraria*, Linnæus. Absent.

13. **A. angustifolium,** Michaux. This species is not found plentifully here. It formerly grew in a piece of rich woods east of the city. Fish mentions it as "not rare" west of the city, in the town of Gates. On low ground, not far from the entrance, in the "Glen," at Seneca Point, on Canandaigua Lake, it grows in some profusion. The writer has carefully looked over hundreds of plants there, as well as at the first station mentioned above and elsewhere, but has never had the good fortune to find a fertile frond of it.

14. **A. thelypteroides,** Michaux. The Silvery Spleenwort is common in rich woods and thickets.

15. **A. Filix-fœmina,** Bernhardi. A common species, and well distributed throughout our region in rich woods.

Scolopendrium, Smith. HARTS TONGUE.

16. *S. vulgare*, Smith. Absent.

Camptosorus, Link. WALKING-LEAF.

17. **C. rhizophyllus,** Link. This interesting fern is rare. It grows east of the city, in the town of Brighton, in some rocky fields in which a few large trees are standing about. It is usually found in

the shade of rocks, sometimes in pockets on the rocks in which a little soil is lodged. Fuller mentions as a station "the east side of Irondequoit Bay, or rather on a small stream emptying into the bay, at the eastern end of the Float Bridge." Fish gives the same station, and also mentions the town of Gates and the "Glen" at Seneca Point, on Canandaigua Lake. At the latter place a few plants of it may be found.

Phegopteris, Fée. Beech-Fern.

18. *A. polypodioides*, Fée. Absent.

19. **P. hexagonoptera,** Fée. A rather common fern in thin woods. Along the lake shore, from the river to the "Sea Breeze," it is found sufficiently plentiful.

20. **P. Dryopteris,** Fée. Fish makes this species as "not rare," but gives no stations for it. Professor Lennon found it in the ravine at Holley.

Aspidium, Swartz. Shield Fern, Wood Fern

21. **A. Thelypteris,** Swartz. The Swamp Shield Fern is common in moist or marshy grounds. Very generally distributed.

22. **A. Noveboracense,** Swartz. The New York Shield Fern is common in moist woods and moist, shady places.

23. *A. fragrans*, Swartz. Absent.

24. **A. spinulosum,** Swartz. This graceful and variable evergreen species, the Prickly Shield Fern, in some of its forms is a common inhabitant of woods, thickets and other shady places throughout our regions. It is reported as found in this vicinity by J. B. Fuller, Geo. T. Fish and Dr. Searing. Mr. Fuller informs me that he has not attempted to determine the variety or varieties of his specimens; as Mr. Fish was a co-collector with Mr. Fuller, it may fairly be presumed that his specimens are in a similar state. Dr. Searing, however, gives this the typical form, as well as the two following. In my own collection I have specimens which I believe may be referred to the two following varieties, but none of the typical species. W. H. Lennon reports *A. spinulosum* from Holley, without designating species.

25 **A spinulosum, var. intermedium,** D. C. Eaton. This is undoubtedly the most common form in this region of the Prickly Shield Fern, or Common Wood Fern.

26. **A. spinulosum, var. dilatatum,** Hooker. This variety, as well as the one above, is reported by Dr. Searing. It appears in my own collection and is marked as having been found at Charlotte.

27. *A. Boottii*, Tuckerman. Absent.

28. **A. cristatum,** Swartz. The Crested Wood Fern is not an uncommon inhabitant of moist and marshy woods and thickets, and even in marshy places in cleared grounds throughout our region. The sterile fronds are evergreen.

29. **A. cristatum, var. Clintonianum,** Eaton. Reported by Dr. Searing, also by W. H. Lennon, as found at Holley. It appears in my own collection of this region without exact locality being mentioned.

30. **A. Goldianum,** Hooker. Goldie's Wood Fern must be considered rare in this region. It is an inhabitant of rich and moist woods and shady places. It is reported by Fish and Fuller in the town of Gates, and by W. H. Lennon in the ravine at Holley.

31. **A. marginale,** Swartz. The Marginal Shield Fern is one of the most common species. Dry grounds more or less shaded and rocky hillsides.

32. **A. acrostichoides,** Swartz. Commonly known as the Christmas Fern. Its fronds are evergreen and are collected for the winter decoration of rooms, for which it is prized. Common in rocky woods.

33. *A. aculeatum, var. Braunii*, Koch. Absent.

Cystopteris, Bernhardi. BLADDER FERN.

34. **C. bulbifera,** Bernhardi. This graceful fern is found in this region wherever the situation is favorable. It inhabits the moist, rocky walls of shaded ravines, depending from their surfaces. River banks north of the city, and Palmer's Glen, on the grounds of James Palmer of Brighton; reported by W. H. Lennon in the ravine at Holley; in the glen at Seneca Point, Canandaigua Lake; common at Watkin's Glen.

35. **C. fragilis,** Bernhardi. The Brittle Fern is very commonly distributed, being found on shaded cliffs, rocky banks, shaded or wooded hillsides and shaded banks of brooks or ditches. The fronds vary greatly, in different plants, in regard to the shape of the pinnules, some being merely toothed, others deeply incised. Besides the common form which all of our local collectors report, Dr. Searing reports var. *dentata*. Specimens in my possession, collected on the farm of the late George B. Benjamin, in the town of Ogden, on the line road between Gates and Ogden, and but a few rods north of the Buffalo Road, present a form the most delicate and graceful I have ever seen. It

appears to be the form described by Eaton, in the Ferns of North America, as var. *augustata*.

Onoclea, Linnæus.

36. **O. sensibilis,** Linnæus. This is the so-called Sensitive Fern, a name of no significance in its application. A common species in moist fields and thickets, widely distributed. This fern is peculiar and interesting as relates to both its sterile and its fertile fronds, which are so widely different.

37. **O. Struthiopteris,** Hoffman. The Ostrich Fern, though not so common as the preceding, is, yet, not rare. It is found in rich, moist soils, in shaded places. The plant presents a grand appearance with its tall fronds arrayed in vase-like form. The tallest specimens which I have seen have been about four feet. Both Gray and Eaton mention the plant as sometimes growing to a height of ten feet.

Woodsia, R. Brown.

38. *W. obtusa*, Torrey. Absent.

39. *W. Ilvensis*, R. Brown. Absent.

40. *W. hyperborea*, R. Brown. Absent.

41. *W. glabella*, R. Brown. Absent.

Dicksonia, L'Heritier.

42. **D. pilosiuscula,** Wildenow. The Hay-Scented Fern is not plentiful in the immediate vicinity of Rochester. The writer has never had the good fortune to find it. W. H. Lennon reports it from the ravine at Holley. Fuller, on the authority of Booth, reports it "Vicinity of Rochester." Fish mentions it from the town of Ontario, in Wayne County, and as he was a careful and industrious collector, the fact of absence of any mention of it close to the city or in Monroe County, with no mention of it by Fuller or Dr. Searing, leads to the conclusion that it is scarce, and perhaps absent from this county. I have seen specimens of it from Allegany County. It is a fern of rather delicate texture, finely cut and very beautiful. Eaton, in Ferns of North America, mentions its habitat as "moist woods, and often in low, grassy places." Gray says, "moist and shady places." Lawson, in the Fern Flora of Canada, says, "stony pastures and way-sides" The same author mentions it as common in Nova Scotia, Quebec, and New Brunswick, but in Ontario, "not common, and

decreasing westward." Apparently it adapts itself to northern, and hilly and mountainous regions.

Lygodium, Swartz. CLIMBING FERN.

43. *L. palmatum*, Swartz. Absent.

Osmunda, Linnæus. FLOWERING FERN.

44. **O. regalis,** Linnæus. The Royal Flowering Fern is not uncommon in this region and may be found in moist, low-lying or swampy grounds, in the open, or in light shade. It has been collected west of Charlotte, at Allen's Creek, along the low ground about the head of Irondequoit Bay, and similar places.

45. **O. Claytoniana,** Linnæus. This is one of the most common species in low grounds, in the open or in shade.

46. **O. Cinnamomea,** Linnæus. The Cinnamon Fern is as common as the last mentioned, and is found associated with it, or alone, in similar places.

ORDER, OPHIOGLOSSACEÆ.

Botrychium, Swartz. GRAPE FERN,

47. *B. Lunaria*, Swartz. Absent.

48. *B. simplex*, Hitchcock. Absent.

49. **B. lanceolatum,** Angstroem. A specimen collected by Joseph B. Fuller is referred to this species. It is also reported by W. Lennon from the ravine at Holley.

50. **B. matricariæfolium,** Braun. Reported by W. H. Lennon from Holley.

51. **B. ternatum,** Swartz. This species is reported by W. H. Lennon as from the same locality as the last two ; and by Fish under the form, *lunarioides*, from the Bergen Swamp in Genesee County. Fuller also reports it under the same name from the same locality.

52. **B. Virginianum,** Swartz. This species is common in our territory in rich woods.

Ophioglossum, Linnæus. ADDER TONGUE.

53. **O. vulgatum,** Linnæus. Specimens of this rare species were collected at Buck Pond by Dr. Searing, in July, 1891. It was also reported several years since by John A. Paine, Jr., to have been found at Henrietta, Monroe County.

The following paper was accepted for publication by the Council:

ON THE SEPARATION AND STUDY OF THE HEAVY ACCESSORIES OF ROCKS.

By Orville A. Derby.

The importance of the study of the accessory elements in rocks is universally recognized by petrographers, and various ingenious and useful methods have been devised for their isolation from the more abundant essential elements in the midst of which they usually play the part of the traditional needle in the haystack. The methods of separation by treatment with acids, use of heavy liquids, and of the electromagnet are essentially laboratory processes, and become expensive and tedious when any considerable amount of material is to be treated. The use of these methods could be greatly extended if the greater part of the essential elements could be got rid of by some rapid and inexpensive process. The primitive panning process of the gold and diamond miner, which depends on the sorting power of water in motion in a suitably shaped vessel, is admirably adapted for this preliminary concentration.

Although the method of washing rock powder in water was employed with striking success by Cordier in the early part of this century, it seems to have been generally neglected until recently revived by Thurach in his admirable studies on zircon, etc. Without knowledge of the latter's methods and results, the writer and his assistants have, during the last few years, employed quite extensively a process suggested by an experienced miner, which differs from that of Cordier and Thurach in the use of the batêa or Brazilian miner's pan instead of the glass or porcelain dishes of the laboratory.

The batêa is a vessel of the shape of a conical kettle cover without the raised rim. The best material is copper, as wood is cumbersome and is liable to retain fine mineral grains in its fibers and thus carry them over from one wash to another, while zinc, tin and iron are more subject to oxidation than copper, and the two latter do not permit the use of the magnet when it is desirable to remove magnetite in the course of washing. Any tinsmith can make the instrument. Tolerably thick sheet copper strengthened with a heavy wire set in the rim should be used, and the joint should be carefully smoothed so as to make the inner surface as regular as possible. A diameter of 12 inches, with an angle of 120° at the apex, gives a convenient size and shape, as it is of sufficient size and capacity to afford as large a residue as will, in most cases, be required, and can readily be carried on excursions in a cloth sack slung from the shoulder. In such a batêa a quantity of crushed or decomposed rock, equal in amount to a large sized hand specimen, can be treated at a single operation, which should generally afford sufficient heavy residue for a considerable number of microscopic slides. If material is scarce, a much smaller volume will usually be found to give a satisfactory result unless the accessories are extremely rare, as fragments (which can be chipped from a museum specimen without injury) representing the bulk of a butternut will give enough for at least one slide.

The knack of washing is readily acquired, and with a little experience one soon learns to vary the process according to the character of the material. In washing a decomposed granite, for example, the first process is to thoroughly disintegrate the mass and to get rid of the clayey portion by kneading and stirring it under water with the hand, pouring off the suspended clay with frequent changes of water. When sufficiently free from clay to permit the granular portion to move freely in water, a vigorous shaking from side to side with a slight circular motion brings a layer of the coarser fragments of quartz and feldspar to the top and, after pouring off the water, this is scraped off with the hand. After repeating this process till the remaining sand is of comparatively uniform grain, a circular motion is given to the batêa which brings a considerable portion of sand into suspension in the water, and permits the heavier and finer grains to settle towards the centre, while the lighter and coarser ones tend towards the surface. By a dexterous jerk the water and moving sand is thrown to the side and, after pouring off the water, the outer portion of the trail of sand on the sloping side of the batêa if scraped off with the hand. After repeating this process until the volume of sand is reduced to about a teaspoonful, it will be noticed that the white color given by the predominance of quartz becomes tinged with black and red through the concentration of the iron minerals and garnet. When, at about this stage, the motion is sufficiently vigorous to set the whole mass swirling about the side of the batêa and is then gradually slowed down, the heavy concentrate may be seen to settle together in a very pretty manner, in a mass at the apex of the batêa, while the quartz swings about in the water on top, When a little farther reduced the behavior of the different minerals according to their specific gravity is most beautifully seen. On throwing the sand out into a trail, it will be found to be transversely streaked with different colors, according to the arrangement of the minerals. The outer part will be white with quartz, then comes a reddish band with garnet, then a black band with titaniferous iron and, finally, (if magnetite is not present, or if it has been removed with a magnet) a white band with zircon, or white and yellow if monazite is also present. This grouping, in which the range of specific gravity is from 2.5 to 5 only, well illustrates the delicacy of the process. Indeed, by skillful manipulation minerals differing so slightly in specific gravity as titaniferous iron and monazite (4.7 to 5) can be almost completety separated when the process is facilitated by a slight difference in the size of the grains. Usually, however, it will be found best to make the separation in the batêa at about sp. gr. 3, throwing away the greater part of the quartz and feldspar and retaining all the heavier elements for further sub-division with heavy liquids.

The whole operation, from the preliminary crushing to the mounting of a microscopic slide, can be performed in a few minutes, usually in less time than is required to prepare a rock section. Thus the least abundant accessories can be determined as quickly and readily as the essential elements, since they appear completely isolated in numerous specimens and with clearly defined crystalline outlines. Accessories so rare that only half a dozen grains or less occur in an ordinary hand specimen will often be found.

The application of the batêa in the laboratory in the preparation of material for microscopic study and for chemical analysis is too obvious to require farther mention. A somewhat extended series of observations indicate that it will prove even more valuable in work which is more strictly geological. This application depends on the two following conclusions, based on several hundred tests of Brazilian rocks, that will presumably be found to hold good for other parts of the world: 1st. Most of the prominent rock groups afford residues which are characteristic, either through the presence of accessories peculiar to each group, or by the relative abundance, or peculiarities of form and structure, of those that are common to several groups. 2nd. Many of the most common heavy accessories are practically indestructable and can therefore be recovered in recognizable form even when the rocks or their debris are so completely altered that their original type is not otherwise recognizable.

Possibly with more extended observations the first conclusion will not be found to be general. This, however, will scarcely detract from its value if the geologist finds that in his limited district he can identify the rock types by their residues, as he has in them a means of forming a definite opinion regarding many rock masses that otherwise would have to be left out of account, or be identified by a mere guess. Rocks too much decomposed for section making will not only give the accessories in a perfect state of preservation, but also some grains of the essential elements that have escaped decay. If sufficiently decomposed to be reduced to a pulp by the pressure of the hand under water, the washing may be done at the nearest stream or pool, and residues representing the really essential part of many pounds weight of rock can be carried home in the pocketbook. The batêa can be as readily carried on excursions as a hammer, and in regions of decomposed rocks will often prove quite as useful. For wrapping the residues, the little books of cut paper for cigarette smokers have been found very convenient. If the rock is still too hard for washing in the field, specimens that otherwise would not be worth carrying home will repay transportation for examination in the laboratory.

A process of what may be called reconstructive geology is thus rendered possible. Several applications of such a process have already been made with complete success, the clue afforded by the heavy residue of a rock completely reduced to clay having been followed through successive stages of decay to the sound rock. For purposes of identification only material decomposed *in situ* should be washed ; but if a quantity is desired, the accumulations of sand in rain-runs or stream beds may be washed with advantage, as they are natural concentrates of the heavy minerals with the quartz of the adjoining rocks.

The minerals most commonly met with in decomposed rocks and in these natural concentrates are the iron and titanium minerals : (magnetite, pyrite, ilmenite, rutile, anatase, sphene, perofskite,) zircon, monazite, xenotime, apatite, tourmaline, garnet, staurolite, epidote, orthite, corundum, spinel, cassiterite, etc. The general distribution of these minerals in sound rocks is pretty well known, though the batêa will often reveal their presence where they would otherwise be unsuspected. The following observations on their occurrence in the residues of decomposed rocks may be of service to those who may feel tempted to try this method of investigation. The greater part of the minerals of the above list appear unchanged even in the most completely decomposed material ; magnetite is occasionally altered to martite and limonite, pyrite to limonite, and ilmenite to an aggregate of microscopic needles of rutile ; rutile (sagenite) and anatase, not present in the sound rock, may appear in the decomposed form, being formed apparently at the expense of ilmenite ; epidote may appear in the partially decomposed rock, but be lacking in the sound and totally decomposed forms, while orthite, sphene and perofskite seem at times to disappear altogether, though the observations on this point are too scanty for a definite conclusion.

The successful application of this method of study of the heavy residues to rocks altered by decomposition, naturally suggests the hypothesis that it may also be of value in the investigation of those that have suffered alteration by metamorphism. Some of the crystalline schists are now generally admitted to be derived by dynamo-metamorphism from eruptives ; others are as generally conceded to be metamorphosed sedimentaries, while the genetic relations of the greater part are still in dispute. Those of the first group should afford residues containing the characteristic accessories of the original eruptive type, either unchanged or in a secondary form, with, perhaps, others that have been produced in the process of metamorphism. Those of the second group, on the contrary, should only afford such accessories as may have existed as transported fragments in the original sediments, or as are susceptible of being produced during the metamorphic process ; the former can generally be recognized by the evidence of wear that they present,* while the latter are well known through the studies on contact metamorphism.

The minerals developed in undoubted metamorphosed sedimentaries are the same that occur in the eruptives, and although the two groups present differences in the aspect, association and relative abundance in the constituents, no certain rule has yet been laid down by which they can be distinguished. Certain silicates, like staurolite, andalusite, etc., are generally regarded as more characteristic of metamorphosed sedimentaries than of eruptives, but as they have been occasionally reported from the latter, and as there is no apparent reason why they should not so occur they cannot be taken as guide minerals. If any such guide minerals are to be found, they must be looked for among those containing the rare chemical elements. The almost universal distribution in eruptives of zircon, with its frequent associates, monazite and xenotime, show that the rare elements zirconium and the various members of the cerium and yttrium groups occur, the first almost universally, the others frequently in eruptive magmas. The usual combination is that of the minerals above mentioned, which only exceptionally (so far as my experience goes only in the comparatively rare potash granites) suffer alteration in the decomposition of the parent rock. Owing to their generally minute size and high degree of hardness they also escape any considerable

*Generally, but not universally, since very hard minerals like zircon, are frequently found in sands and gravels with as sharp angles and brilliant lustre as in any eruptive rock. A rounding of the angles cannot always be taken as evidence of wear as some minerals, especially zircon and monazite, are often rounded in undoubted eruptives. A lacklustre aspect without evidence of alteration is the most certain sign of wear. The grains of the softer minerals in the residue can be appealed to in cases of doubt.

amount of wear in the formation of sedimentaries from eruptives, so that it may be said that, when occurring in the former, these elements are still in the original packages. Moreover, in virtue of their high specific gravity (near 5) they become concentrated in the coarser arenaceous deposits, being almost completely sifted out of the finer argillaceous ones, as can be verified by a comparative wash in any sand and mud bank. Unless, therefore, these rare chemical elements are introduced into the mass subject to metamorphism by the action of the so-called mineralizing agents, (as fluorine, boron and tin are supposed to be in the formation of tourmaline, topaz and cassiterite,) it is difficult to conceive how the minerals in question can appear as new formed elements in a metamorphosed sedimentary. Their early crystallization and uniform distribution in eruptives, as well as their absence from schists metamorphosed by contact (in the rare cases in which zircon has been noticed it may be presumed to have existed in the original sediment) exclude the hypothesis of such an introduction.

On the hypothesis of a sedimentary origin for the crystalline schists that so frequently contain zircon alone, or zircon and monazite, we should expect these minerals to show more or less distinct signs of wear and to characterize quartzose rather than feldspathic rocks. The observations thus far made that bear upon this point are as follows: schists free from quartz, such as amphibolites and amphibole schist, often show an abundance of perfectly, sharply defined and fresh looking zircons; staurolite-bearing argillaceous and micaceous schists often fail to show zircon, or give only a few grains, usually with a worn appearance; the Brazilian gneisses and feldspathic mica schists have never failed, so far as tested, to show zircon, more frequently than otherwise associated with monazite, in about the same abundance and with the same perfection of form and lustre as is found in the typical granites.*

The first of these observations is contrary to the antecedent probability above established, but in harmony with the studies of Lossen, Williams and others, as well as with the field observations in Brazil, tending to prove the derivation of many of the amphibole schists from eruptives. The second case, in which the schists are unquestionably of sedimentary origin, confirms the *a priori* reasoning regarding the probabilities of the appearance of minerals of the rare elements in metamorphosed sediments. The third observation is in accord with an opinion now held by a number of able geologists that many of the

*Chroustschoff's observation (Tschermak's Mittheilungen, VII, 1886) that granite is characterized by sharp angled and gneiss by rounded zircons, does not hold good when a larger series is examined. In both rocks perfectly sharp angled crystals are the exception rather than the rule, and apparently characterize the amphibolic rather than the micaceous types.

gneissic rocks are dynamo-metamorphosed phases of eruptives and affords an additional argument ln favor of this view.

There is thus a reasonable probability that zircon, and to a less degree monazite, may prove to be guide minerals by which eruptives and their derivatives can be certainly identified, no matter what degree of alteration they may have suffered. This probability gives an additional interest to the study of the heavy residues of rocks which, it is hoped, will lead geologists to thoroughly test this hypothesis in other parts of the world.

In conclusion, a word on the discrimination of monazite and xenotime may not be out of place, since the extremely minute grains in which they occur in the residues are often liable to be confounded with other minerals or with each other. Mr. Allen Dick, of London, has kindly examined some of my slides with the spectroscope and finds that the smallest grains can be readily distinguished by the absorption bands of didymium in monazite, and of erbium in xenotime. By bringing, by the use of condensers beneath the stage, the image of the sun, or of a small lamplight, *within* the grain and substituting an ordinary hand spectroscope for the eye-piece, the bands can be distinctly seen.

APPENDIX.

Since the above was written the receipt of a collection of American rocks from the National Museum of Washington has permitted a comparison of their heavy residues with those of the corresponding groups of Brazilian rocks. By chipping from the specimens, residues were obtained from 18 granites and 9 gneisses which, though too small for a complete study, were sufficient for a determination of the more abundant and characteristic accessories.

Zircon was found in all, the rounded and sharp cut forms being about equally distributed in the granites and gneisses and frequently occurring together in the same specimen. In the gneiss of Ayer, Mass., and White Mountain Notch, N. H., the crystals are small and rare and in this respect are similar to those from the mica schist at the top of Mt. Washington, N. H., where their character is such as might be expected in a metamorphosed argillaceous sediment. They are, however, equally rare and small in some of the granites, particularly in that of Fairfield, S. C., and Somerville, Me., in the latter of which geniculated twins occur. The crystals are especially abundant and handsome in the granite of Otter Creek, Mt. Desert, Me., Hurricane Ils., Me., Ilchester, Md., and the gneiss of Endfield, N. H. and

Pascoag, R. I. In the granite of Vulcan, Menominee Co., Mich., they are discolored as if by superficial alteration.

Monazite, giving the absorption band of didymium, occurs in the granite of Westerly, R. I., Narragansett Pier, R. I., and the gneiss of Wessford and Ayer, Mass., Randolph, and East Pond, Waxefield, N. H. In the gneiss of East Blue Hill, Me., are grains that might be referred, from a microscopic examination alone, to monazite, but that fail to give the spectroscopic test, possibly from a deficiency of didymium. It is particularly abundant and characteristic in the Westerly granite and Randolph gneiss. In the latter the aspect of the mineral is precisely that of the Brazilian localities, while in the former its color and appearance is quite different from any yet seen elsewhere. The strong absorption band, high specific gravity and phosphoric acid reaction serve to identify it as monazite.

Xenotime appears in minute octahedral crystals identical in aspect with those of the Brazilian rocks, in the gneiss of Wessford, Mass. The muscovite granite of Narragansett Pier and the pegmatite of Auburn, Me., which looked favorable for this mineral, failed to show it, possibly from insufficiency of material examined.

Orthite has already been reported by Messrs. Hobbs, Cross and Iddings from two of the rocks examined, viz., the granite of Ilchester, Md. and Vinal Haven, Me. Grains identical in appearance with these occur in the granite of Somesville and Hurricane Ils, Me., Batesburg, S. C., Burnett, Texas, and the gneiss of Pascoag, R. I. and Endfield, N. H. The granite of Ryegate, Vt. may also contain it though the grains look more like sphene, which mineral probably occurs also in some of the other rocks mentioned, although with the material at hand it cannot be positively distinguished. In the Brazilian rocks orthite has been found in the granite of Itaquy in Sao Paulo and the gneiss of Santos, Sao Paulo, and Areal, near Petropolis, Rio de Janeiro. In all of these localities the mineral disappears on the decomposition of the rock, which is probably the reason that it has not been more generally met with, since most of the washings have been made on decomposed material. All the Brazilian, and apparently the greater part if not all the American, rocks affording orthite carry hornblende which, in the case of Areal at least, has been in great part altered to biotite. There is thus apparently a relation between the presence of hornblende and the crystallization of the elements of the cerium group as a silicate instead of a phosphate as monazite, the usual form in the purely micaceous rocks. That this is not due to the absence of phosphoric acid is proved by the presence of apatite in all the rocks examined.

The widespread distribution of the elements of the cerium group in the form of the easily decomposed orthite may perhaps bear a relation to the phosphatic nodules, evidently of secondary origin, containing these elements in the diamond gravels of Brazil (Gorceix, Bul. Soc. Min. de France, Fol. VII, 1884, page 179) and which will probably be found elsewhere.

Rutile was noted in the granite of Ryegate, and Craftsbury (orbicular granite) Vt., and Silver Mt., Madison Co., Mo., and in the gneiss of Ayer, Mass., and East Pond, Waxefield, N. H. The very abundant mineral referred to rutile in the latter may prove to be cassiterite.

Apatite is about as universal as zircon in the rocks examined and is usually quite abundant.

In the course of the examination several indeterminable minerals were met with of which the most notable are yellow isotropic grains, in the granite of Somesville, brown isotropic ones in that of Winnsboro, S. C., and white ones with a bluish cast in that of Vinal Haven that may prove to be corundum.

The rocks examined but not specially mentioned in the foregoing are the granites of Milford, Mass., Dedham, Mass., Newberry, S. C. and Fairfield, S. C., and the oligoclase gneiss of Swanzey, N. H.

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