# FIRST REPORT

OF THE

# MICHIGAN ACADEMY OF SCIENCE

COVERING THE TIME FROM THE ORGANIZATION OF THE ACADEMY IN 1894 TO JUNE 30, 1899

PREPARED UNDER THE DIRECTION OF THE COUNCIL

By WALTER B. BARROWS, Secretary



BY AUTHORITY

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# FIRST REPORT

OF THE

# MICHIGAN ACADEMY OF SCIENCE.

## LETTER OF TRANSMITTAL.

To Honorable Hazen S. Pingree, *Governor of the State of Michigan:*

Sir—I have the honor to submit herewith the First Annual Report of the Michigan Academy of Science, for publication in accordance with Section 14 of Act No. 44, of the Public Acts of the Legislature in 1899.

Respectfully,

WALTER B. BARROWS,

Secretary of the Michigan Academy of Science.

Agricultural College, Mich.,

December 1, 1899.

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## ORGANIZATION.

In March, 1892, after discussing with his co-workers in the University the question of the desirability of a State society of naturalists, Professor Jacob Reighard addressed to a score of well known men in the State the following circular letter:

Ann Arbor, Mich., March 22, 1892.

Dear Sir—It is proposed to organize in Michigan a State Society of Naturalists to comprise Zoölogists, Botanists and Physiologists. As a preliminary to a call for a meeting to organize such a society it is desirable to get an expression of opinion from those most likely to be interested upon the following points:

1. As to the scope of the work to be done by such a society.
   - (a) To what extent should papers embodying the results of original work be presented at the meetings?
   - (b) What stress should be laid on the discussion of methods of teaching and the demonstration of appliances for teaching?
   - (c) To what extent should general biological problems be discussed (such for instance as heredity) with a purpose of stimulating an interest in them and securing a better understanding of them?
   - (d) Should an attempt be made to stimulate, systematize and co-ordinate work on the fauna and flora of the State, and can any means be devised of giving worth to such work and accumulating the results of it in such a way as to make it a permanent acquisition of the science?
2. What should be the character of the membership?
   - (a) Should it be composed wholly of investigators, or
   - (b) Should it include also those engaged in teaching without intention of ever engaging in investigation? or
   - (c) Should it include all persons sufficiently interested to discharge the duties of membership?

The character of the membership is largely determined by the scope of the work and it is of course necessary to have at least a tentative policy with regard to membership before calling a meeting for organization.

The organization of such a society will be greatly facilitated if you will give your opinion as fully as possible on each of the foregoing points, and also on the following:

I. Will you become a member of a society of the character indicated by your reply?

II. Give the names and addresses of such persons as in your opinion would be likely to become desirable members of such a society.

III. At what time and place should the meeting for organization be called?

IV. Could you contribute to the program of such a meeting if one were called?

Replies should be addressed to J. E. Reighard, Ann Arbor.

(Signed.)

V. M. SPALDING,
Professor of Botany.
W. H. HOWELL,
Professor of Physiology.
J. E. REIGHARD,
Asst. Professor of Zoölogy.
J. B. STEERE,
Professor of Zoölogy.

The answers received to this letter were various, but all agreed, or nearly all, that an organization was desirable and that the membership should not be closely restricted.

Owing to press of work on the men whose names are signed to the letter the matter was carried no farther at that time.

In the spring of 1894 the matter of a State society was again discussed at the University, but three of those whose signatures stand at the close in the preceding circular letter could take no active part in immediate effort since Professor Spalding was absent in Europe, Professor Reighard was about to leave for Europe, and Professor Howell was no longer connected with the University.

At that time Professor F. C. Newcombe, finding that others were willing to coöperate, prepared, with the help of Professors Steele and Lombard, the following circular letter, which was sent to about fifty people in the State, calling for a meeting for purposes of organization.

UNIVERSITY OF MICHIGAN,
BOTANICAL LABORATORY.
Ann Arbor, June 21, 1894.

From inquiries made of various persons throughout the State, it has been found that there is a general desire for the organization of a State Natural History Society.

The replies to these inquiries have indicated a two-fold work for such a society: (1) co-ordinated scientific research; (2) improvement of methods of teaching. The active membership of the society should therefore consist of investigators and teachers and others directly interested in natural history.

The undersigned therefore unite in issuing a call for a meeting for the organization of a State Natural History Society at Ann Arbor, Wednesday, June 27th, 4 o'clock p. m., in the University Main Building, Room 11, to which you are invited.

The meeting will be addressed by Dr. Steere of the University, Professors Beal and Wheeler of the Agricultural College, Professor Scherzer of the State Normal, Professor Ward of the Michigan Fish Commission Survey and by others. At this meeting, besides the organization, it is hoped to get some profitable work under way.

If you cannot attend, please address a reply, with your willingness or unwillingness to become a member of the society, to Frederick C. Newcombe, Ann Arbor, Mich.

JOSEPH B. STEERE,
Professor of Zoölogy.
WARREN P. LOMBARD,
Professor of Physiology.
FREDERICK C. NEWCOMBE,
Asst. Prof. of Botany.

The following is a copy of the minutes of the meeting held in response to this call:

### MINUTES OF THE MEETING FOR ORGANIZATION OF A STATE NATURAL HISTORY ASSOCIATION.

(Held at Ann Arbor, Michigan, June 27, 1894.)

Pursuant to a call issued in a circular letter signed by J. B. Steere, Warren P. Lombard, and Frederick C. Newcombe, and sent to about fifty people of the State, over twenty-five persons assembled in Room 11, University Hall, at 4 o'clock p. m., June 27, 1894.

The meeting was called to order by F. C. Newcombe, who proposed Dr. W. J. Beal for chairman. Dr. Beal was elected unanimously. F. C. Newcombe was then elected secretary.

The secretary then rehersed the inception of the movement for an organization beginning with the circular letter of enquiry signed by Professors Spalding, Howell, Steere and Reighard, and sent out two years before.

There seeming to be unanimity of feeling as to the need and usefulness of a State organization, the scope of such a society came up for discussion. In the informal discussion part was taken by I. C. Russell, J. B. Steere, W. B. Barrows, H. B. Ward, Bryant Walker, J. Montgomery, C. F. Wheeler, W. J. Beal, and F. C. Newcombe. The general opinion expressed was that the society should hold stated meetings for the reading and discussion of scientific papers and should also seek to forward the scientific study of the resources of the State as well as the fauna, flora, and so forth.

Bryant Walker moved that the officers of the association, with the addition of two members, be constituted an *advisory board* to report a constitution and by-laws, to arrange a program, and to call the next meeting. The motion was carried.

On motion of W. B. Barrows it was resolved to include the whole State in the work of the society.

After some discussion on a suitable name for the society, the matter was referred to the advisory board.

As officers of the temporary organization, W. J. Beal was chosen president, J. B. Steere, vice-president; F. C. Newcombe, secretary and treasurer. As the two other members of the advisory board, W. B. Barrows and I. C. Russell were elected.

The meeting then adjourned subject to the call of the advisory board.

(Signed) F. C. NEWCOMBE,
Secretary.

List of persons who signed, or by letter gave permission to sign, their names to a membership list of a State Scientific Society, June 27, 1894, at Ann Arbor, Michigan:

W. J. Beal, Agricultural College.
Walter B. Barrows, " "
Charles F. Wheeler, " "
W. H. Sherzer, State Normal School.
E. A. Strong, " " "
Lucy A. Osband, " " "
W. H. Munson, Hillsdale College.
Chas. A. Davis, Alma College.
Frances E. Stearns, Adrian College.
Bryant Walker, Detroit.
Oliver A. Farwell, Detroit.
Robert H. Wolcott, Grand Rapids.
J. W. Matthews, " "
Hattie M. Bailey, " "
Delia A. Bailey, " "
J. B. Shearer, Bay City.
H. B. Ward, Nebraska University, Lincoln, Nebraska.
J. Montgomery, Ann Arbor.
J. B. Steere, University of Michigan.
Warren P. Lombard, " " "
I. C. Russell, " " "
F. C. Newcombe, " " "
D. C. Worcester, " " "
L. N. Johnson, " " "
Charles A. Kofoid, " " "
H. C. Markham, " " "
A. J. Pieters, " " "
J. H. Schaffner, " " "
E. H. Edwards, " " "
H. S. Jennings, " " "
S. D. Magers, " " "
Charles Carpenter, " " "
Mrs. E. G. Willoughby, " " "
Margaret Weideman, " " "

The organization having now a formal existence, the next step was toward securing a good membership roll. To this end the following slip and circular letter were prepared and sent out to about twenty newspapers and to two hundred people of the State.

Address........................

Date......................

Frederick C. Newcombe, Ann Arbor, Mich.

DEAR SIR—I hereby agree to become a member of the proposed State Scientific Society.

On the reverse side of this slip I have given the names and addresses of other persons whom it would be desirable to have join the society.

Name......................

Ann Arbor, Mich., September 15, 1894.

DEAR SIR—At a meeting of about twenty-five persons, held in Ann Arbor, June 27, 1894, it was unanimously agreed that it was desirable to form a society for the purpose of scientific research in the State of Michigan.

At this meeting, the officers whose names were appended were elected to serve until a permanent organization should be effected and were instructed to act as an advisory board with the duty of recommending a constitution and by-laws for adoption by the society, and of preparing a program for the next meeting.

At a meeting of the advisory board it was unanimously agreed to recommend that the name of the society be the "Michigan Academy of Sciences," and that it have for its principal object the study of the agriculture, archeology, botany, geography, geology, mineral resources, zöology, etc., etc., of the State of Michigan, and the diffusion of the knowledge thus gained among men. It is not the opinion of the advisory board, however, that the work of the society should be restricted to the subjects named but should be enlarged from time to time as occasion may require.

A constitution and by-laws have been drafted and will be submitted to the society for revision and adoption at the coming meeting. It was also agreed to recommend that the dues of members of the organization be $2.00 for the first year of membership, and $1.00 per year thereafter.

The first meeting of the society will be held during the coming winter, date and place yet to be determined, when the organization will be completed and a plan of work attempted.

The members of the provisional organization were heartily in accord in wishing that all persons in the State of Michigan who are interested in scientific work should be urged to join the society and assist in contributing to its usefulness.

The undersigned, constituting the advisory board, respectfully request you to join the society, and also to present the names of others who may become desirable members.

If you are in sympathy with this movement, will you kindly fill out the enclosed blank and mail it as addressed?

For further information regarding the character and object of the association, inquiries may be addressed to the Secretary, at Ann Arbor, Michigan.

W. J. BEAL, President, Agricultural College.
J. B. STEERE, Vice-President, Ann Arbor.
F. C. NEWCOMBE, Secretary, Ann Arbor.
W. B. BARROWS, Agricultural College.
I. C. RUSSELL, Ann Arbor.

Several of the State press published the substance of this circular and by the first of December, 1894, there were members enrolled to the number of eighty-six.

Meantime the advisory board had been busy preparing a program for a winter meeting and drafting a constitution.

In the early part of December Dr. W. J. Beal, of the Agricultural College, prepared the following slip, which was enclosed by the State Teachers' Association in the same envelope with their program, and sent to all members of the said Association.

A STATE ACADEMY OF SCIENCES.

In June last about twenty-five persons met in Ann Arbor and effected a temporary organization of a State Academy of Sciences. They adjourned to meet again at Lansing in December to perfect the organization, present papers and lay out work for the future.

All persons interested in the work of such a society are cordially invited to meet with us in the Pioneer Room of the State Capitol, on Wednesday, December 26, at 2 p. m. standard time.

W. J. BEAL, President.
J. B. STEERE, Vice-President.
[Signed.] F. C. NEWCOMBE, Secretary.
I. C. RUSSELL.
W. B. BARROWS.
Executive Committee.

In the middle of December there were sent out to all members of the preliminary organization, to one hundred others who had been recommended for membership, and to sixty of the State press, the following circular, together with the program of the first meeting of the Michigan Academy of Sciences.

Ann Arbor, Mich., December 12, 1894.

The Michigan Academy of Science was organized last June for the promotion of fellowship among scientific men, and for scientific research in the State. It is hoped that all people directly or indirectly interested in the objects of the society will become members.

At the Lansing meeting, December 26 and 27, organization will be completed. It is probable that the initiation fee will be placed at one dollar, and the annual dues at one dollar. There are no other limitations to membership. Fees do not become due till after the Lansing meeting.

Let everyone who will aid this society by becoming a member, send his (or her) name and address immediately to the secretary.

FREDERICK C. NEWCOMBE,
Ann Arbor, Michigan.

By order of executive committee.

Such were the steps leading up to the formal organization of the Michigan Academy of Science, which took place in the Pioneer Room of the State Capitol, December 26 and 27, 1894.

In pursuance of instructions given by the Academy at its first meeting the council at once took proper steps to incorporate the Academy under the laws of the State, and on February 6, 1895, articles of association of the Michigan Academy of Science were filed with the Secretary of State.

# FIRST ANNUAL MEETING—DECEMBER, 1894.

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The first annual meeting of the Academy was held at Lansing, in the Pioneer Room of the Capitol, December 26 and 27, 1894, President W. J. Beal in the chair. The following items of business were transacted.

Constitution and by-laws were adopted.*

Sections were organized in zoölogy, botany, and sanitary science, as follows:

Section of Zoölogy—Vice President, Prof. J. E. Reighard, of Ann Arbor; Prof. D. C. Worcester, of Ann Arbor, to act during the absence of Prof. Reighard in Europe. Three sub-sections were formed also.

Section of Botany—Vice President, Prof. F. C. Newcombe, Ann Arbor.

Section of Sanitary Science—Vice President, Dr. Henry B. Baker, Lansing.

A resolution calling on the Legislature for improvement in the manner of registering births and deaths, was referred to a committee, which subsequently framed such a request and submitted it to the Legislature.

A similar resolution recommending to the Legislature the preparation of a good topographic map of the State, showing also the surface geology, was referred to the council, and the matter afterward brought to the attention of the proper legislative committees.

A resolution was adopted urging the prompt passage of Bill 119, House of Representatives, of the 53d Congress, 2d session, relating to the protection of Forest Reservations.

A resolution was adopted endorsing the scientific work of the Michigan Fish Commission, and the council was instructed to prepare and present to the Legislature a petition for an increased appropriation for the continuance of the biological examination of the waters of the State by the commission.

Provision was made for the preparation of a charter for the Academy, under the general laws of the State.

The treasurer's report showed the expenditure of $23.67 up to December 26, 1894.

Officers for the ensuing year were elected as follows:

President—Bryant Walker, Detroit.

Vice Presidents.
- Zoölogy—J. E. Reighard, Ann Arbor.
- Botany—F. C. Newcombe, Ann Arbor.
- Sanitary Science—Henry B. Baker, Lansing.

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*For copy of these, as adopted, see page —— this report.

Secretary—Chas. A. Davis, Alma.
Treasurer—E. A. Strong, Ypsilanti.

Papers presented at the First Annual Meeting of the Michigan Academy of Science, Lansing, December 26 and 27, 1894.

1. The Mammals of Michigan. Dr. J. B. Steere. Not Published.
2. The Birds of Michigan. Prof. D. C. Worcester. Not published.
3. Additions to the Flora of Michigan. C. F. Wheeler. Published, with further additions, in the report of the Secretary of the State Board of Agriculture for 1898, pp. 82-91.
4. The Cryptogamic Flora of Michigan. L. N. Johnson. Not published.
5. Work of the Michigan Fish Commission. Prof. H. B. Ward. A preliminary report, never printed; for complete report see Bull. 6 of Mich. Fish Commission.
6. The Dinobryons of Lake Michigan. Dr. C. A. Kofoid. Not published.
7. Our Society and a State Survey. Dr. W. J. Beal. Printed in full in this report. See index.
8. Practical Benefits of Bacteriology. Dr. F. G. Novy. Printed in full in this report. See index.
9. Simian Characters of the Human Skeleton. Prof. W. H. Sherzer. Printed under the title "Platycnemic Man in New York" in Report of State Geologist [N. Y.] Vol. III, Paleontology, 1893, pp. 659-683.
10. Data and Development of Michigan Archaeology. Harlan I. Smith. Part I. Notes on the Data of Michigan Archaeology. American Antiquarian, May 1896. Part II. The Development of Michigan Archaeology.—The Inlander, VI. No. 8, 1896.
11. Some Notes on the Michigan Coat of Arms. Prof. W. J. Beal. Printed in full in this report.
12. Flora of Michigan Lakes. Prof. Chas. A. Davis. Printed in full in this report.
13. Michigan Lepidoptera. Dr. R. H. Wolcott. Not yet published. Outline in this report.
14. Review of our Present Knowledge of the Molluscan Fauna of Michigan. Bryant Walker. Published by the author. Detroit, 1895. (pp. 1-27.)
15. Distoma petalosum; a Parasite of the Crayfish. C. H. Lander. Not published.
16. Bacteria and the Dairy. Prof. C. D. Smith.
17. Tendencies in Michigan Horticulture. A. A. Crozier. Printed in full in this report.
18. Futile Experiments for the Improvement of Agriculture. Dr. Manly Miles. Printed in full in this report.
19. Vital Statistics. The Scientific Basis of Sanitation. Dr. C. L. Wilbur. Printed in full in American Lancet (Detroit), February, 1895.
20. The Uredineae of Michigan. Harriet L. Merrow. Not yet published; abstract in this report.

## OUR SOCIETY AND A STATE SURVEY.

BY W. J. BEAL.

(Read before the Academy, December 26, 1894.)

Perhaps it may not be wise at present to say very much about our young State Academy, as its reputation is yet to be made either for performing long continued thorough work or for making desultory efforts.

The thought of forming such a society is not new, but has been more or less discussed at different times for thirty years or more. The organization has long been delayed, because the number of capable scientific people willing to sacrifice time, money, and hard unremunerative labor has been very small. And these live in parts of the State remote from each other. Even at this time none of us anticipates a large membership or any very striking results—at least, not for many years to come. Each one of the members sees already any amount of interesting work in natural science that ought to be done in our State. Let us from this time forward, strive to interest others to join us and begin and carry to completion some of the investigations so much needed.

The importance of making a survey of the fauna, flora, and other natural resources of the State was recognized as early as 1837, and a fair beginning was made, though for want of persons to press the subject; little has been accomplished excepting to continue the geological survey; and this has been maintained, merely because of the brilliant and prompt financial results which were anticipated. Michigan is far behind many other states east, west, and south in the study of fauna and flora. Primitive conditions are fast disappearing. In hundreds of townships, there are only fragments here and there which still contain the native wild plants. These regions have been cleared up and now bear farm crops. The swamps and marshes have been drained; the woods pastured; the roadsides cultivated for crops almost to the tracks made by passing teams. Fires have repeatedly burned over some of the most interesting portions of the State. Extensive tracts of timber have been cut and removed, and before the young timber could cover the ground and begin to repair the waste, fires have licked up nearly every green thing.

A good force of competent persons should be continually employed to look after the forests of the State—to investigate their needs and to discover and apply the remedies. I need not go into details. It would be interesting to learn the location of the different regions of the State and the special plants which characterize them. How is each of these regions related to others in this State and in neighboring states.

As members of a scientific society, we ought to be able to render considerable assistance in seeing that these subjects are properly taught in the public schools, and that young persons begin and maintain numerous local museums where the natural history may be investigated.

These plants may be listed and grouped with reference to their many uses; for roadside planting, for color of foliage, for ornamental flowers, for climbing, for display in winter, for growing in ponds and bogs, or on sand, in the sun or in the shade, for spring, summer, or autumn. Which are most useful for furnishing bees with honey and where do they thrive? What native weeds have we, and what is the list of exotic weeds? Active efforts should be made and continued to discover and record the introduction of new plants, and the modes of introduction. The problem of weeds on the farm and in the garden is one of imminent importance. The parasitic fungi are awaiting investigation, as they ruin the hopes of many of our industrious cultivators of the soil. Tons of valuable food, as good as roast beef, are annually wasted because of the ignorance of the people regarding their peculiarities. These mushrooms and toadstools should be better known for many reasons.

Local societies for investigating this subject should be encouraged and assisted.

Our mammals, birds, reptiles, fishes, insects, crustacea, mollusks, and even the lowest kinds of animal life need more attention; and we have not the least doubt that their study would add to the wealth of the State three dollars for every one judiciously expended in this work.

A number of committees, each headed by an enthusiastic and persistent naturalist should begin to make plans for the future, and then we need means from the State to print and illustrate these reports and papers. We must remember that nothing of importance can be accomplished without labor.

I congratulate you as members of an organization which has no lack of interesting and useful work to perform.

## PRACTICAL BENEFITS OF BACTERIOLOGY.

FREDERICK G. NOVY, ANN ARBOR.

(Read before the Academy December 26, 1894.)

Within a comparatively short period of time, perhaps 15 years, the field of knowledge has been enlarged by a new science—bacteriology. The study of bacteria, as such, may possess a great deal of interest to the microscopist and botanist yet it is safe to say that without the recognition of the extraordinary significance of these organisms this sudden and remarkable evolution of the science would be impossible. Bacteria had been known and studied, more or less, for a hundred years and more, yet the impulse from the practical side was necessary to attract at once scores and even hundreds of investigators into the field. We may not inaptly compare, so far as development is concerned, bacteriology with electricity. Electricity had been known for more than a century, but it required an Edison and a Bell to develop its practical side just as bacteriology required a Pasteur and a Koch. It is well known what electricity has done, but is it known what has been accomplished by and through bacteriology?

To obtain a correct impression of the results of bacteriology it is necessary to begin with the pioneer work of Pasteur, nearly 40 years ago. At that time fermentation was explained by the great German chemist Liebig as a purely chemical phenomenon. Pasteur as a chemist was led to question this explanation and in a series of elaborate experiments effectually disproved this view and firmly established the relation of certain microscopic organisms to fermentation and putrefaction. The chemical theory of fermentation of Liebig was forced to give way before incontrovertible evidence and facts to the vitalistic theory of Pasteur. Today we no longer speak of the vitalistic theory for it has ceased to be a theory. No series of facts in chemistry or in physics can be said to be more clearly proven than the relationship of bacteria, yeast, etc., to fermentation and putrefaction. This indeed, has greater significance than may at first appear. Fermentation and putrefaction, the decomposition of vegetable and animal matter, is carried on constantly on the earth's surface. Without this decomposition, the nitrogen of the proteid molecule and the carbon of the carbohydrate and proteid molecule would be as useless to new plant life as the $CO_2$ stored away in the vast deposits of limestone within the earth's crust. Through the agency of the minute single-celled organism, the chief representative of which are the bacteria, these complex dead molecules are split up in $CO_2$, $HNO_2$, $HNO_3$, and other products which are then utilized by new life. The law of conservation of energy and of matter finds its parallel in conservation of life. Decay and putrefaction from this standpoint is not, as Pasteur has pointed out, a phenomenon of death so much as a phenomenon of life.

The relation of bacteria to fermentation is of the greatest practical importance. Many of the products to which they give rise are directly utilized by man. In this sense bacteria are directly beneficial—a fact which is too often lost sight of and indeed overshadowed by the injurious action of some forms of bacteria on man and animals. To illustrate what great practical and industrial importance is attached to certain microorganisms we may mention the yeast plant. All the alcohol of commerce is derived by fermentation induced by the yeast cell. Practically all the acetic acid, that is vinegar, is obtained through the fermentative action of bacteria on alcohol. Other substances such as lactic acid, butyric acid, etc., are obtained from the same source. The vast deposits of soda saltpetre in South America and the saltpetre of India owe their origin unquestionably to the industrious bacterial cell.

Bacterial decompositions or fermentations occur to a large extent among certain foods. Indeed many articles of food, such as cheese, butter, koumiss, etc., owe their special flavors and characteristics largely to the fermentation changes which have taken place. The study of bacteria has further shown that many foods, as meat, milk, cheese, etc., may take on poisonous properties, the result of the formation of poisons within the food by the special bacteria which have been introduced and have developed therein. Some of these bacterial poisons, especially those which are basic in character, and thus chemically closely allied to the vegetable alkaloids, are of great practical importance in legal medicine. In their chemical reactions they may easily be mistaken for poisonous alkaloids and thus lead to the conviction of otherwise innocent persons. That such fatal mistakes have been committed is perhaps only too true. The lessons that have been gained by experience and through the labors of Selmi are now so well recognized that it is no longer an easy matter to secure conviction in such well known poisonings as strychine, morphine, etc.

That which has brought bacteria most into prominence is unquestionably their relation to disease. Ever since the discovery of the microscope there have been bold thinkers who did not hesitate to declare that communicable diseases as syphilis, smallpox, etc., were due to living forms. The germ theory of disease, which may be said to have been born in the mind of Kircher more than two hundred years ago, has after a series of remarkable vicissitudes become firmly established. A theory ceases to be a theory when facts have been accumulated and proofs furnished. This has been done with a large number of infectious diseases, so that today, to speak of the germ theory of disease is to confess a lack of familiarity and a lack of knowledge of the growth of one of the most important branches of medicine. The germ theory is a thing of the past. Bacteria and other organisms are the causes of infectious disease. This has been proven as clearly as any demonstration can be made. We do not theorize when we state that arsenic, strychine, morphine and similar chemical compounds are poisonous. Neither do we theorize when we say that the anthrax bacillus produces anthrax, the tetanus bacillus tetanus, the glanders bacillus glanders, the hog cholera bacillus hog cholera, or the tubercle bacillus tuberculosis. These and others have been proven to produce these diseases, not once, but hundreds and thousands of times. Every student in a bacteriological laboratory becomes personally acquainted with these disease producing organisms and with their action in the animal body.

In order to prove that an organism is the cause of a given disease, it is necessary to comply with certain requirements.

Briefly stated, these are as follows: First, the specific organism must be present in every case. Merely to be present does not prove that it is the cause as it may be an accompaniment or a consequent of the disease—a possibility, which, though extremely improbable, must nevertheless be conceded. Secondly, this specific organism must be isolated in a perfectly pure form, free from all other organisms and foreign substances. In other words a pure culture must be obtained, just as the chemist before applying his final tests, isolates the substance in a condition of chemical purity. Thirdly, the pure culture of the organism when properly introduced into a susceptible animal must produce the disease.

If these requirements are satisfied it is evident that there is no escape from the conclusion that that special organism is the cause of that disease. Demonstrations of this kind have been furnished in a very large number of diseases of man, of animals and even of plants. Anthrax in cattle and in man was the first disease shown to be due to bacterial origin. And it may be perhaps of interest to add that the last disease which has been proven to be due to bacteria is the recent plague in China, which is the same as the plague which devastated Europe in the preceding centuries under the name of black death. This interesting demonstration has been simultaneously and independently achieved by Yersin of Paris and Kitasato of Tokio.

The fact that bacteria produce disease is unquestionably an important one. But of much greater significance to man are the results which necessarily follow. As long as such diseases as cholera, typhoid fever, tuberculosis, diphtheria were supposed to have some obscure ill defined cause, it was well nigh impossible to successfully combat these diseases. With the demonstration that bacteria are the cause is furnished something that is definite and tangible.

These organisms can now be isolated and artificially grown and their weak points, so to speak, readily ascertained. In this way it becomes possible to establish a rational method of prevention of the communicable diseases. The great advances which have taken place in sanitary science during the last quarter of a century are directly the outcome of the study of bacteria. Thousands of lives have been saved through the facts disclosed by the investigation of these organisms. The scientific prevention of disease can be seen nowhere as well as in brilliant achievements of surgery.

To Joseph Lister is due the credit of having utilized the facts gathered by Pasteur on fermentations, and of having applied these facts to surgery, long before a single germ was actually proven to be the cause of a disease.

Antiseptic and aseptic surgery is the pride of medicine, since the principles laid down by Lister, extended and widened by more recent investigations on bacteria have enabled the surgeon to accomplish results and to save life to a degree which otherwise would be impossible.

Another name must not be forgotten in this connection. Indeed it cannot be forgotten, for wherever there is a mother, consciously or unconsciously she must render her grateful thanks to that benefactor of womankind and of the entire human race, who devoted the best years of his life to free woman from the unnecessary dangers of childbirth. At the recent International Congress of Hygiene, held in Budapest last September, a monument was erected to perpetuate the memory and works of Ignatius Semmelweiss.

In the antiseptic methods of prevention of infectious diseases which have been alluded to, the attempt is made to prevent the disease by removing the causative organism through rigid cleanliness or by preventing the growth of the organism, or actually destroying it by means of chemical substances or germicides. A knowledge of the means whereby bacteria can be destroyed is of the greatest practical benefit to every person. It is clear that if the organisms can be prevented from growing in the body the disease cannot originate. Quarantine or isolation and disinfection have these objects in view. The results thus obtained in preventing the spread of infectious diseases are only too well known.

Many of the communicable diseases may be prevented by other means than those outlined. It is a matter of experience that frequently one attack of a disease prevents against a second attack. This fact was recognized 3,000 years ago by the Chinese and utilized to prevent the spread of smallpox. Variolation as practiced in the far East was introduced into western Europe not quite 200 years ago. This method of insuring protection against the disease was replaced a hundred years ago by the safer and equally efficacious method of vaccination of Jenner. We do not even now at the close of the 19th century know what the cause of smallpox is, yet we are in possession of a perfect means to prevent this dreaded scourge. Vaccination prevents the disease from developing within the body. It confers immunity or freedom from that disease.

The principle of vaccination was not extended until 14 years ago, when Pasteur in his study of the germ of chicken cholera, observed that after a time it lost its virulence, that it became weakened. The genius within the man at once indicated the practical application of this fact. Vaccination with cowpox protects against smallpox and this was assumed to be due to the fact that cowpox was a modified or weakened form of smallpox. Acting on this assumption, Pasteur attempted to vaccinate animals against chicken cholera by first inoculating them with the weakened culture of the chicken cholera bacillus. In this he was successful and perfect immunity to the disease was obtained. Means were discovered by Pasteur for weakening or attenuating other disease organisms and in this way successful vaccinations were made in animals against anthrax, symptomatic anthrax, malignant œdema, hog erysipelas etc. Since then the chemical products of these organisms have been employed with equally successful results in inducing immunity to disease. The means which are now known for producing immunity in animals against infectious diseases are almost too numerous to mention.

The fact however is established that artificial immunity to disease may be produced in animals against a large number of infectious diseases.

Practical methods of vaccination against certain animal diseases have been perfected by Pasteur and his pupils. This is notably true in chicken cholera, hog erysipelas and in anthrax. This principle has not been extended to man unless we include under this head the last great work of Pasteur on the prevention of hydrophobia. We have but to look over the 30 years of constant work devoted by Pasteur to the study of bacteria in order to appreciate the incalculable benefits which have been conferred on science and on humanity by this master.

The prevention of hydrophobia in persons bitten by mad animals is the crowning achievement of a long life's work. The names of Jenner and of Pasteur will endure as long as science itself, as long as there are men willing to search for truth.

The prevention of the spread of infectious diseases is without doubt one of the greatest and most fruitful results of the age. But the bacteriologist cannot and must not stop at this point. The rational treatment of the disease itself claims his attention. A few years ago a distinguished physician gave utterance to the statement that the study of bacteria as causes of disease, though interesting in itself, could not furnish any means to treat such diseases. Today, it is otherwise. The bacteriologist has already entered upon the cure of infectious diseases and even now two diseases have been robbed largely of their dreaded character. These are tetanus and diphtheria. The blood serum therapy which has been developed and perfected by Behring, Kitasato, Roux Tizzoni and others marks the dawn of a new era. The brilliant results in curing tetanus and especially diphtheria in man will prove all the more an incentive to the further study of these and other diseases.

Such are some of the practical results, accomplished by bacteriology. To utilize those organisms which are useful to man and to destroy those which are injurious, either before or after they secure an entrance into the body of men and animals, constitutes in brief the line along which incalculable benefits will accrue to man.

I cannot close this necessarily brief paper without a plea for the introduction of the study of bacteria into our lower schools. Education must extend from below upwards and it is time that such a beginning be made in the study of bacteria. I would not ask, at least for the present, that a special course be given to this subject, but I would ask that classes in botany be instructed as to the nature of bacteria and their role in nature and in disease; that the classes in hygiene or in physiology become acquainted with the principal infectious diseases and their prevention. As matters now stand only the favored few in universities and in medical colleges become acquainted with the facts that are of vital importance to all. The mass of the people can never be reached in this way. It is well to teach children the antidotes for poisons, what to do in case of accident, drowning, etc., the evils of tobacco and of alcohol. Why should not the most deadly foe of man receive a like attention?

Hygienic Laboratory, University of Michigan.

# THE GREAT SEAL AND COAT OF ARMS OF MICHIGAN.

BY W. J. BEAL.

(Read before the Academy December 26, 1894.)

The design for the great seal of the state of Michigan was presented by the Hon. Lewis Cass to the convention which framed the first constitution for the state, in session at the city of Detroit, on the second day of June, 1835, and was afterwards adopted on June 22, 1835. In one of the rooms of the secretary of state is now a design in lead pencil. The drawing is rather dim, but most interesting. There is also in the same office a description of the great seal, which reads as follows:

"A shield shall be represented on which shall be exhibited a peninsula, extending into a lake, with the sun rising, and man standing on the peninsula with a gun in his hand. On the top of the shield will be the word 'Tuebor,' and underneath in a scroll will be the words, 'Si quæris peninsulam amœnam circumspice.' There will be a supporter on each side of the shield, one of which will represent a moose and the other an elk. Over the whole, on a crest, will be the eagle of the United States with the motto, 'E pluribus unum.' Around will be the words, 'Great seal of the state of Michigan, A. D. MDCCCXXXV.' "

There is also there preserved a letter from the president of the convention, which reads as follows:

" Detroit, June 24, 1835.

"To the secretary of the territory of Michigan:

"In conformity with the following clause in the constitution adopted by the convention now in session, I transmit you the within description and accompanying device for deposit in your office, hereby certifying that they are the papers to which reference is made in the said clause, viz:

" 'A great seal for the state shall be provided by the governor, which shall contain the device and inscription represented and described in the papers relating thereto, signed by the president of the convention and deposited in the office of the secretary of the territory.'

JOHN BIDDLE.

"President of the Convention."

I have been interested in looking over various editions of the Legislative Manual and numerous state reports, letter heads, encyclopedias, histories, geographies, etc., which contain various caricatures of the design adopted. In the original the eagle looks very well and life-like, with his wings spread and the tips turned downward. At the left, as we look at the design, is the elk, with the neck arched more than it should be to represent nature; at the right stands the moose, with arched neck, a very slight crest along the middle of the neck and shoulders, but nothing like the shaggy mane as shown in recent cuts that are used in various reports. The horns are broad, much like those of a moose, the forehead is too much curved or dished, the nose slants off somewhat abruptly, like a blunt chisel sharpened on one edge, instead of the true round, blunt apex as the animal wears it. There is a small goatee and a very short, spike of a tail.

The first design of the coat of arms as used in the public laws of Michigan appears in 1839, and continues to 1872, inclusive. In this (shown in Fig. 1) the moose stands at the left instead of at the right, and under him and beyond may be seen part of a train of short cars, and under the elk a plain steamboat. The eagle is spreading his wings in a graceful position as though just about to fly. The moose has a narrow nose much like that

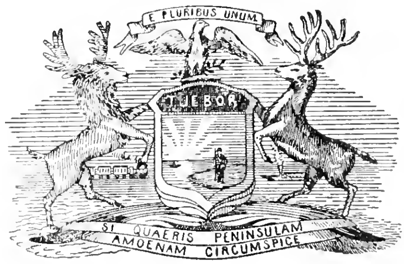


FIG. 1.

of the elk, and a shaggy neck considerably resembling the neck of a long-haired dog which had been closely sheared from the rear to the shoulders.

In 1870, in some state reports, there is a change (as shown in Fig. 2.) The shield is shorter and broader, the eagle has risen above it, but still clings to his arrows; and now it is difficult to distinguish the moose from the elk, and both resemble bucks more nearly than an elk. On the left a man seems to be picking into a mine, on the right the boat has arrived. This boat is modified in style, when compared with the one above figured, having a mast as well as a smoke stack. The design was for a long time used as a part of the heading of the Lansing Republican.

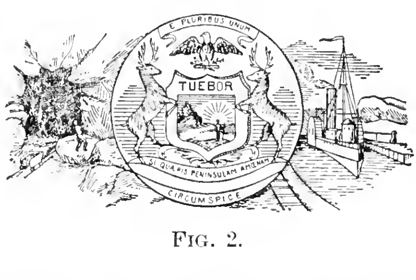


FIG. 2.

In 1879, while the Hon. C. A. Gower was superintendent of public instruction, another design was used in his report—(Fig. 3). Great changes appear. The elk and the moose with sharp noses and smooth shoulders becoming tired of standing on their hind legs all these years, drop down onto all fours, waltzing around or one chasing the other, till they finally stop with the moose to the right of the shield. The eagle was evidently frightened at this and raised, extending his wings considerable, perhaps fearing the shield would tip over for lack of support. The railway train is of a different type and is close onto the heels of the moose. Farther back are a house and a barn, and in front a man plowing, and near the railroad a telegraph line is seen. On the left appears to be a factory of some kind, perhaps a sawmill.

In 1880 (as shown by Fig. 4) there is another change; the eagle has alighted on the shield, but the tips of his wings point up in a strained position against the strip which holds the motto, "E pluribus unum." The cars and telegraph have left all traces of existence, the steam boat has departed; the house and factory have been swept away; the plowman has

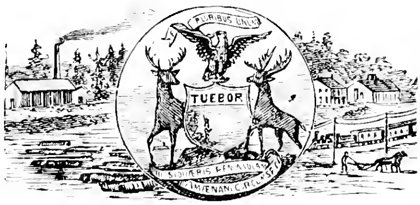


FIG. 3.

probably gone to dinner; the sun shines more brightly; the moose has again found his own horns, which look as though they were stuck on the head of a calf; the shaggy mane has been toned down, and here we have the fourth form of the shield that has appeared. The moose and elk having taken a rest for two or three years have again reared on their hind feet and support the shield in a graceful manner.

In 1883-84 there are again signs of a great commotion. (See Fig. 5.) Gov. Begole comes into office. The rays of an imaginary sun concealed by

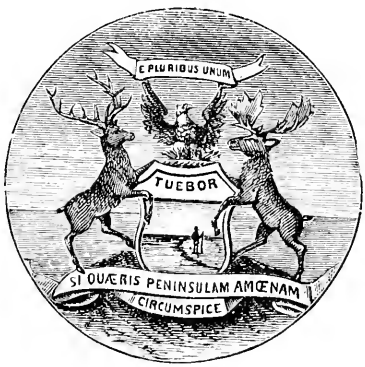


FIG. 4.

the shield, flash far up into the sky beyond the shield, and a great cloud of dust or smoke appears on each side back of the elk and moose. The rays of the visible sun rising from the distant lake are not parallel with the rays emanating from back of the shield. The moose has changed his head and again has found his shaggy neck. The eagle is the same as on the former design. In all these changes the latin mottoes are not disturbed.

At the top of some of the paper now and for some years used by the executive department is what is called a fac simile of the great seal of Michigan. The eagle rests on the top of the shield, with wings raised in a frightful and unnatural position, the tips apparently supporting the motto above. The elk looks reasonably well, excepting the conspicuous growth of long, shaggy hair all about the neck, quite in contrast with the smooth head and body. The head of the moose is too much like the head of the elk, the neck and shoulders are shaggy and unnatural. Back


FIG. 5.

of the last two animals named are clouds of smoke, dust, or mist. On the shield is the man with a gun standing on a peninsula. The gun has a bayonet attached. Neither on the shield nor outside of it are there any other signs of animal or plant life, save those just mentioned, nor of art, save the mottoes and the arrows in the possession of the eagle.

One of the letter heads now in use (Fig. 6) contains another design here exhibited. The eagle has dropped his wings; the strip containing the motto takes a bend under his neck. The rays of a second sun flash up

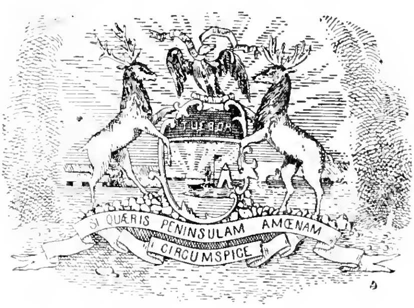


FIG. 6.

back of the eagle, the other sun just rising above the water on the shield. The shield is of a different design from any of the others. Excepting the slight difference in the horns, the moose is essentially the same as the elk. The train of cars and a steamboat reappear, with some changes. The moose and the elk stand on piles of small stones, clouds appearing on either side. Near the man on the peninsula stands a flag pole bearing the stars and stripes and a tent of modern design. The great seal of Michigan, as used in 1870 or thereabouts was much more like the original design than the one used at present.

In the legislative manual for 1885 and for several years after there is apparently a copy of the state seal as now used. Near the margin are the letters, "Great seal of the state of Michigan, A. D. MDCCCXXXV."

The eagle is slightly changed from the one last described, this one having on the head two slight horns pointing backward. Altogether, when carefully viewed with a lens, it is a very clumsy bird. The man on the peninsula has again changed his clothes, the bayonet has been removed from the gun. The elk is very good, having very little indication of long hair about the neck. The moose has a rather broader nose, the hair on the neck and shoulders is quite long and wavy. Except the shield, the


eagle, moose and elk and the strips containing the mottoes, the ground work is all plain, consisting of fine parallel lines.

I have by no means exhausted the deviations from the original drawing at first described, but have shown that no two of them are alike in some rather important particulars. It seems as though the engraver of each new plate for a state coat of arms or state seal had tried to exhibit some originality in his work as others have in making innumerable representations of Uncle Sam.

Perhaps it makes little difference how many styles we have—we live in an age of fashion—but some day, I doubt not, some careful person will revise the figures of our state seal and we shall have an improvement on any yet made. There could certainly be nothinng to criticise, were the drawings good and true to life of a perfect eagle, a handsome elk, and a well-proportioned moose. In case no one else undertake the job, it would not be a bad scheme for this society in its printed transactions to have a design made which should be a credit to its members by exhibiting the eagle, the elk, and the moose as well-developed animals, all in graceful positions.

# THE FLORA OF MICHIGAN LAKES.

CHARLES A. DAVIS, ALMA.

(Read before the Academy, December 27, 1894.)

With the three largest great lakes practically within her territory, with a fourth lying on her border and more than 5,000 smaller lakes and ponds scattered over her surface, Michigan offers exceptional opportunities for the study of fresh water plants, and it is the purpose of the present paper to put the facts already known relating to the flora of our lakes into such shape that they will be available for future use. The lakes of the State exclusive of the Great Lakes cover an area of 1,225 square miles, or more than 784,000 acres, or about 1-50 of the total area of the State, and they are so distributed that there is hardly a botanist in Michigan who cannot readily reach one or more of them.

The small lakes, particularly those of the Lower Peninsula, are commonly depressions in the drift, shallow and not of large extent, frequently partially filled in around the margin with the remains of former generations of plants, so that many of the typical features of lakes of hilly or mountainous regions are partly supressed or entirely wanting. These lakes belong to a recent geological time which undoubtedly accounts for some of their peculiarities. By far the larger number of them exhibit the following features: A small sheet of water of roughly elliptical shape bordered by a marshy area of varying width, which is limited on two or more sides by low, abruptly sloping, sandy or gravelly hills. The marshy tract is frequently wider on the south side than on the north, and its character varies from a quaking bog at the inner margin through a sphagnous zone into a swamp in which the prevailing trees may be tamarack, cedar, or spruce, or all of them. The plants of the sphagnum zone are characteristically those of the boreal life zone and in such lake margins we find northern plants reaching their southern limits. The quaking bog is usually a lakeward extension of the shore plants and is a closely woven turf of the roots and rootstocks of various species of Carex, Cyperus, grasses and at its outer margins, sometimes of Typha latifolium and Sparganium eurycarpum, partly resting, partly floating on a bed of loosely coherent vegetable debris into which the unwary investigator may find himself sinking, if he is not constantly on the lookout for his footing. In the larger lakes the marshy border may not extend entirely around the margin, but it is usually noticeable along the southern shore where it may be of considerable extent, while the rest of the shore is entirely without it. Such are the lakes.

The work which has been done in connection with the flora of these bodies of water has been of a decidedly desultory and irregular sort, and the published accounts of such work, meager and largely confined to simple lists of the species of the Metaspermae found growing in the lakes which have been visited by our collectors. Sometimes these lists are accompanied by notes relating to the variations of some of the species, but usually the accounts are very short. A notable exception is the work done on Lake St. Clair in 1893, by the Michigan Fish Commission party under

Professor Reighard of the University of Michigan to which attention will be called later.

Prof. Charles F. Wheeler of the Michigan Agricultural College and Prof. L. H. Bailey, of Cornell University, have made a careful examination of the Metaspermae of Pine Lake, near Lansing, and with most satisfactory results, adding to our knowledge of the geographical distribution of certain rare plants, some of them new to our flora, and finding the lake an exceptionally rich field, about fifty species of aquatics being recorded from it. Rev. E. J. Hill, of Engelwood, Ill., has made a careful and systematic study of the plants along the shores of Lake Michigan and the adjacent region, and of the Naidaceae in particular, and has added much to our knowledge of the distribution and character of the Michigan species of those polymorphous plants, by publishing his notes relating to them from time to time in the botanical periodicals. Dr. Thomas Morong made collecting trips into Michigan in search of aquatic plants, the results of which are embodied in his monumental work on the North American Naidaceae. Dr. D. H. Campbell made a study of the plants of the Detroit River in 1886. Mr. O. A. Farwell, now of Detroit, made an extensive study of the plants of Keweenaw county, including the aquatics, bringing to our knowledge among other interesting species the Myriophyllum which now bears his name. Mr. C. K. Dodge, of Port Huron, has collected for a number of years along Lake St. Clair, the St. Clair River and neighboring waters and sends me a considerable list of species of flowering plants which he has found in those bodies of water.

Supt. H. T. Blodgett, of Ludington, has made some study of the flora of Hamlin Lake in Mason county, and the small lakes in that vicinity, which prove themselves rich in aquatic plants by the species which he has found. Messrs. Beardslee and Kofoid have collected in various parts of less settled portions of the Lower Peninsula, particularly in Cheboygan county; and Mr. S. H. Camp, of Jackson, has made limited collections of aquatics in the course of general collecting. Mr. G. H. Hicks, Dr. W. J. Beal and doubtless nearly all other botanical collectors of the State should be added to the list, as occasional collectors of the plants of our lakes to a greater or less extent.

The result of this work is that we have a general and rather diffuse knowledge of about a hundred species of the Metaspermae, more than half of which it is safe to say that not a half dozen botanists in the State would recognize at sight, if he found them. The main fact that we know of them is that they are reported to occur within the boundaries of the State, in some cases, augmented by the less perfect knowledge that they occur at intervals over a considerable portion of it, but it may be truthfully said, I think, that there our knowledge ends in the case of the most of these species. The work done has been largely finding and recording species and there it has ended.

Such work has a decided scientific value undoubtedly, and should not be underrated, and certainly is not by me, but with only our catalogue of names we surely have a very meager and unsatisfactory knowledge of the plants of our lakes. A careful study of the various lists of plants of the State, however, brings to light a number of interesting facts. It shows that comparatively few of our lakes have been even visited by botanists, and still fewer have been thoroughly searched. It shows that several of the aquatic plants are known but from a single station or from two or three widely distant ones, while comparatively few are known from a large number of stations. Lastly, we may look in vain, with one exception, for contributions of any sort to the knowledge of the myriad forms of Algae and other groups of flowerless plants with which the waters of our lakes fairly teem.

It is evident from the foregoing considerations that the botanists of this body have a duty to perform, and as we shall have to begin at the foundation, let us look at the field from various standpoints. In a discussion of the flora of our lakes from any point of view, we shall have to place the four great lakes in a group by themselves, because from their great size and depth special conditions which do not obtain in the smaller lakes, have to be considered from their effect on plant life. It is also well, at the beginning of any subject on which it is proposed to make extended investigations, to establish a series of terms whose meaning shall be exactly defined and strictly limited in application, so that there shall be no confusion as the work progresses. Therefore, since American literature contains nothing of general application relating to the plant life of fresh water, in this paper I propose to adopt the suggestions of Haeckel and other German writers in regard to terminology, for the German biologists have, with characteristic energy, already made a number of studies of the life of fresh water lakes. Since the term "pelagic" has already been applied to those forms of plants and animals which are found freely floating or swimming at various depths in the open ocean, it is suggested by Haeckel that similar forms in our fresh water lakes be called limnetic and that they be divided into auto-limnetic, zono-limnetic, and bathy-limnetic groups, according as their habitat is the surface, intermediate zones, or the depths of the lakes. For the total swimming and floating population of fresh water lakes the term limno-plankton, as opposed to halo-plankton or simply plankton, for salt water forms. The general adoption of these or equivalent terms will avoid whatever confusion might arise from the use of older terms heretofore applied to salt water life-forms. These terms are general, applying to all forms of organisms. These living organisms are animal as well as plant and in the lower orders the line of demarkation is faint and not sharply defined, but it is not necessary to enter into a discussion of the distinction between the two groups here, as we will consider those forms of life which are ordinarily called plants by good authority, as such, leaving disputed groups to be classified later. If botanists had adopted the use of the word protophyta to apply wholly to unicellular plants, it would have been possible to adopt Haeckel's classification dividing all plants into protophyta and metaphyta, the former applying wholly to one-celled the latter to the tissue forming forms, but at present, usage is opposed to such a scheme. For our purpose it will be well to separate the visible and larger from the invisible and smaller forms, into macroscopic and microscopic. The macroscopic plants are of two types, the amphibious and the truly aquatic. The amphibious plants may be farther subdivided into those forms which grow habitually in the water on the edge of the marshy border, the truly littoral forms, and those which grow in the marsh itself, and are capable of living through a considerable period of submergence during their growing season, the palustrine forms.

The true aquatics or hydrophytes, are those plants which grow wholly submerged or with but a small portion of the growing apex of the stem together with the inflorescence, emersed. These plants are usually but lightly rooted, their stems and leaves are filled with large air spaces and in the exogens, the leaves are frequently much dissected into long filamentous lobes. In the endogens, on the other hand, the submerged leaves are commonly entire and frequently have broad blades. The line separating these two divisions is not a very sharp one as many of the species which are commonly pure aquatics will frequently survive for long periods growing on muddy or sandy banks from which the water has receded, and the amount of adaptation to the changed conditions which some species will show in these circumstances is remarkable and suggestive. The aquatic plants also have the ability to survive for a considerable period floating freely in the water and undoubtedly this power is of material aid to them in assisting in their distribution in a given body of water.

In discussing the flora of Lake St. Clair in Bulletin No. 2 of the Michigan Fish Commission, Mr. Pieters has adopted the terminology of Magnin, whose work on the lakes of the Jura demonstrated the existence of a series of zones in the littoral and aquatic plants of that region. These zones, which Mr. Pieters found more or less well marked in Lake St. Clair, are limited by the depth of the water in which they lie and there are certain dominating genera of plants characterizing each zone. The zones of Magnin are four in number; 1st. A littoral zone subdivided into Phragmitetum and Scirpetum, the former extending to a depth of 2-2½ meters, the latter to 3 meters. 2d. The Nupharetum, from 3 to 5 meters. 3d. The Potamogetonetum usually extending to 6 or 7 meters; and below 8 meters, 4th., the Characetum. In Lake St. Clair, the prominent plants of the first zone are *Phragmites communis* Trin., *Typha latifolia*, L., *Acorus Calamus* L., and several others. Two species were characteristic of the Scirpetum. *Scirpus pungens* Vahl., and *S. Lacustris* L., the latter growing in the deeper water. The 2d. zone, the Nupharetum was wanting, *Nuphar advena* belonging to the Phragmitetum, but the third, the Potamogetonetum, characterized by the true aquatics, was well defined, extending into water from 3 to 7 meters deep. The chief plants were various species of Potamogeton, the most common being *P. perfoliatus* L., which, together with *Vallisneria spiralis* L. was abundant. Beyond this zone and covering the whole bottom of the lakes, so far as studied, the Characetum was found in which various species of Characeae formed the prevailing vegetation. These plants were found most abundant on clay and alluvial bottoms, much less so on sands. Mr. Pieters also points out that these zones were not well defined in shallow parts of the lake and where the bottom sloped very gradually.

Professor Reighard in Bulletin No. 4 of the Michigan Fish Commission mentions three factors which may influence the abundance of plant life in a lake: 1st. The amount of plant food which the water contains; 2. The amount of shallow water in the lake; 3d. The transparency of the water. I would add a fourth, as decidedly influencing the number of macroscopic plants, namely, the character of the bottom near the shore, sand being very nearly if not quite barren, while alluvial and clay deposits are usually richly inhabited. The plants of all of Magnin's zones are more or less influenced by these conditions, especially, by the 2d and

4th. The latter fact is made quite clear by the statement of Mr. Pieters in regard to the Characetum.

The microscopic plants of our lakes may be roughly divided into two groups, those which attach themselves to plants and other objects in the water and at the bottom, and those which freely move about. Many of the larger Algae, such as Vaucheria, etc., and the fixed diatoms belong to the first and desmids furnish examples of the second group. By microscopic plant in this sense, those forms requiring the use of the compound microscope for determining species are meant. Our knowledge of these plants as found in Michigan waters is so limited that but little more can be said in regard to them, but it is highly probable that they form both directly and indirectly an important factor in the distribution and the supply of fish in our lakes. With the facts above presented in regard to Lake St. Clair in view, even though it is not a type of our smaller lakes, it will be well to view the latter and see what bearing they may have in a general way on the distribution of our lake plants. To any one who has visited any number of the lakes which dot our Lower Peninsula, it will be easy to recall the fact that in the deeper ones with abruptly sloping bottoms, the amount of visible vegetation is small, being usually limited to a narrow zone near the shore, and in the shallower ones, the amount is larger, the plants extending farther out, and in very shallow ones covering the whole surface. In most of these lakes, if not all, undoubtedly careful study would reveal a certain correspondence in the essential features of the vertical distribution of the macroscopic plants, mainly dependent on the width of the various zones, which in turn would be found to depend on the slope of the bottom. The species predominating in one lake would not necessarily nor likely be the same, as it is frequently the case that one species will secure the entire ground available to the type in a lake and monopolize the field while in an adjacent lake some other species or a group of specie will do the same. Mr. H. T. Blodgett writes me that in one small lake with which he is acquainted the entire surface is covered with *Utricularia intermedia* so much so that during the blooming season the air is fragrant with its sweetness, while in another pond connected with it, the much rarer *Utricularia purpurea*, is the exclusive plant. It is also true that certain species colonize a portion of the shore of the lake and will not be found except in that limited area. In the water which I have most carefully examined, a mill pond made by damming Pine River, and consequently a shallow and irregular basin, the predominating plants of the macroscopic flora, are *Elodea Canadensis* in the shallowed portions and *Heteranthera graminea* in the deeper, but besides these there are at least nine species of Potamogeton, all of which are fairly abundant, but more or less in colonies, each species growing in limited areas by itself. *Ranunculus circinatus* is very common also in large patches, as is *Vallisneria spiralis*. In such a pond the zones in larger bodies of water and natural lakes could not be expected to be well defined, as the bottom is very irregular and the deepest part is in the old river channel. Still, it is a noteworthy fact that certain species are restricted to the deeper water and that the littoral zone is fairly well marked and some characteristic species are abundant. In this zone is the third recorded station of the rare hybrid *Carex lupulina x retrorsa* Dudley.

Let us now consider briefly what ought to be done to redeem the reputation of the botanists of Michigan in regard to this field. 1st.: Every effort should be made to complete the filling out of the list of macroscopic species and to work out the limits of the geographical and vertical distribution of each form. 2nd.: A systematic study of the microscopic forms, about which practically nothing is known, should be undertaken and carried out. 3d.: The biological interrelations of plants and animals should be fully worked out, for the problem is one of great commercial as well as scientific interest, for Michigan is rapidly becoming the banner summer resort of this whole section of the country, and her lakes are attracting a large number of people to their banks, and in part, the fish of the lakes form the attraction. We must know the conditions that are most favorable to animal life in the lakes if the attraction is to remain a permanent one, for already the fish population of most of them is perceptibly diminished. 4th.: The special problems of distribution and propagation of the mascroscopic aquatic vegetation are well worthy of solution and form an attractive field for investigation. 5th.: Still more interesting, perhaps, is the series of questions suggested by the special forms of leaf and stem developed by the submerged aquatics which have never been looked into in connection with American species. 6th.: The study of the modifications presented by the flowers of aquatics to bring about cross fertilization, and to prevent blighting by wind and wave; the means for encouraging the visits of insects have been neglected and even worse in America and should be taken up. 7th.: The various physiological and anatomical changes brought about by the peculiar environment of this whole group of plants can be studied to advantage. These are some, indeed but a few, of the problems in pressing need of solution in connection with the plants of our smaller lakes. Shall we undertake to solve them? One question suggests itself as exceedingly interesting and I would invite the attention of the systematic botanists to it. There is a variety of species of flowering plants that seem to prefer the cracks of floating logs as a habitat. In it they invariably take a depauperate and starved form which is quite characteristic and undoubtedly a number of such forms could be made into variety minors, etc., that would stand criticism quite as well as many we already have. The problem of the flora of the Great Lakes is of such magnitude and importance that I hesitate to approach it with my present lack of knowledge. A gentleman entirely familiar with the subject, a botanist of more than national reputation called my attention to the fact that while the ocean, bays and inlets and even the exposed coasts teemed with vegetation, the great lakes were barren of it. My home was on the Atlantic coast and I would modify the above statement in regard to the ocean by adding the words, "except where there is sand." The sand coast is entirely without vegetation and is nearly without animals. My only experience along the Great Lakes was a year spent in Chicago, where I noted the lack of visible vegetation in the waters of Lake Michigan at that point, but had my attention repeatedly called to the fact that the artificial ponds in Jackson Park, which were directly connected with the lake by a wide canal, were constantly being dredged out by the gardener to prevent their being overgrown, a fact that indicated that the waters of the lake were not lacking in plant food. Since I have given more thought to the matter I am inclined to ascribe the lack of littoral vegetation in these lakes to three causes:

1st.: The prevalence of sand along the entire shore line, which prevents the starting and growth of young plants, on account of its sterile and movable nature; 2nd.: The rapid slope of the bottom in most places into deep water, which would tend to make the littoral zone very narrow, and brings it into the part of the shore line most acted on by waves; 3rd.: The prevalence of swift currents and strong high waves, which keep the sand in motion and prevent the formation of shoals of finer materials. That there is a flora of considerable extent in Lake Michigan is shown by the fact that Mr. L. N. Johnson reports finding bushels of *Nostoc pruniforme* along the southern shore of the lake and says that he has seen it in ridges two to four feet wide and six to eight inches deep. In such shallow estuaries as the mouth of the Saginaw River where silt is deposited in abundance, there is often an abundant and varied flora. The determination and study of the plants of the Great Lakes can hardly be undertaken by individuals, but must be done largely at the expense of corporations or government on account of the large expense involved in properly equipping for the study.

In closing, a few words of suggestion in regard to collecting aquatic plants may not be out of place. If a boat is accessible it is exceedingly useful in getting about on the water to be investigated, but not essential unless the lake has a shallow slowly sloping bottom. Many plants can be reached from the shore in any case and such collecting as can be done in this way is often satisfactory as to results. Some form of dredge is essential and can be made by fastening a series of hooks into a lead disk about three inches in diameter. Through this an iron rod 5-16 of an inch in diameter and about a foot long, bent to form a small ring at one end, is passed so that the disk is below the center. The hooks are 12 to 14 in number and are all bent toward the same side, projecting about an inch and curving inward about an inch. The rod should project about three inches from the disk at the lower end, so that the end will strike the bottom first. The disk should be made heavier on the side toward the hooks which are best made of steel wire. Another form, the one used by the Michigan Fish Commission is described by Mr. Pieters in his account of the Flora of Lake St. Clair. The rope is attached to the ring, and besides being used as a dredge, the instrument may be used for taking soundings if nothing better is at hand and the water is not too deep. For collecting the lacustrine forms of microscopic plants a small bolting cloth towing net is essential.

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2. Manuals and Monographs.
3. General Treatises.

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## THE LEPIDOPTERA OF MICHIGAN.

R. H. WOLCOTT, M. D., GRAND RAPIDS.

(Read before the Academy, Dec. 27, 1894.)

[Abstract.]

I. Introduction:
  1. Situation of state.
  2. Divisions of state.
  3. Configuration of surface—Lower Peninsula.
  4. Configuration of surface—Upper Peninsula.
  5. Geological strata.
  6. Climate.
  7. Flora.

II. Distribution of animal life in state:
  1. Relation to great faunal provinces.
  2. Division of the state into faunal regions.
  3. Causes changing these divisions.

III. The Insect Fauna with especial reference to Lepidoptera:
  1. General remarks on Insect Fauna.
  2. Classification of Insecta.
  3. Lepidoptera.
  4. Classification of Lepidoptera.
  5. List of families and superfamilies.

IV. Review of Lepidoptera of state:
  1. Rhopalocera—110 species.
  2. Sphinges—47 species.
  3. Sesias—12 known species, probably 50 altogether.
  4. Bombyces—150 species.
  5. Noctuae—550 species, estimated.
  6. Geometrae—200 species.
  7. Microlepidoptera—Pyralites, 150 species, estimated.
  8. Tortrices—100 species, estimated.
  9. Tineina—250 species, estimated.
  10. General Survey—1600 species total.

V. Suggestions as to work:
  1. Gathering of facts—Methods of collecting.
  2. Collecting immature stages.
  3. Labeling.
  4. Identification.
  5. Works of reference.

VI. Conclusion.

## TENDENCIES IN MICHIGAN HORTICULTURE.

ARTHUR A. CROZIER.

(Read before the Academy, December 27, 1894.)

Recognition of the peculiar advantages of Michigan as a fruit growing state may be said to date from the publication in 1866 by Alexander Winchell of his researches upon the climatology of the region of the Great Lakes. He then demonstrated the previously unsuspected fact that these inland bodies of water exert upon the climate of the surrounding territory an equalizing influence "truly comparable to that exerted by the great oceans." Dr. Winchell pointed out that for a period of eleven years the coldest temperature reached at the Straits of Mackinac was only one degree lower than at the city of Chicago during the same period. In calling attention to this fact Dr. Winchell at the same time expressed his belief that so far as winter-killing was concerned peach orchards and vineyards would be perfectly secure along the whole eastern shore of Lake Michigan.

At the time this prediction was made there was only one county in the state extensively engaged in fruit growing, namely, Berrien, lying in the extreme southwest corner of the State. We now have the well known "Michigan fruit belt," extending along the line suggested nearly thirty years ago, and lacking but one county of completing the entire distance from the head of Lake Michigan to the Straits of Mackinac.

One other physical fact bearing upon the successful cultivation of the tender fruits was first popularly demonstrated at about the time this lake influence became known. I refer to the influence of minor elevations upon temperature. The fact that the summits and slopes of ordinary hills, having an elevation of no more than fifty to one hundred feet, may in extremely cold weather be enough warmer than the low lands adjoining to make all the difference between the success and failure of a fruit crop, or in the case of peaches even the life and death of the trees, was first pointed out so far as I know by Hon. J. G. Ramsdell of Traverse City.

These two facts, the ameliorating influence of the Great Lakes upon the general climate and the modifying effect of air drainage upon the local temperature, were taken up by the Michigan State Horticultural Society upon its organization in 1870 and thoroughly impressed upon the people of the state as of fundamental importance in the cultivation of fruit. And it is chiefly because the fruit growers of the state have recognized these facts and have acted in accordance therewith that Michigan occupies its present advanced position among fruit growing states.

Meanwhile other natural features of our state are having their influence upon the development of its horticulture. The extensive swamps and marshes which retarded the early settlement of the state are now proving as valuable for the production of vegetables as are the higher hills for the production of fruit. Quietly, and probably unknown to the majority of our citizens, many of these unsightly and unwholesome lands have been reclaimed and are now producing the finest crops of onions, cabbages, cauliflowers, celery, peppermint, as well as some of the ordinary farm crops. It is said that more than one-half of the world's supply of the oils of peppermint, spearmint and tansy is produced in this State; Michigan celery is regularly shipped to all the leading markets in the United States from Denver to the Atlantic seaboard.

The evident adaptation of these swamp lands to market gardening purposes, and the large amount of such land in this state still unreclaimed, render any facts connected with their further development of general interest. The question of draining these swamp lands has been quite thoroughly studied and is not generally a difficult one to solve. Several other matters, however, need to be considered. Over drainage has often to be guarded against. Where the water supply comes from the surface only drainage sometimes leaves a muck swamp in a condition to suffer from drouth more severely than the adjoining upland. Such lands, it is well known, may even take fire in a dry time and lose much of their value by burning away. Probably the chief advantage possessed by swamp or marsh lands is their having generally a more abundant and more constant water supply than the uplands. To conserve this supply of water is therefore important, and it is a point that needs to be considered at the time of draining. Some swamps are so situated by the side of streams, or at the foot of living springs, that moisture can at all times be maintained within proper distance of the surface by means of ditches. I know also of marshes in this state under a high state of cultivation which are abundantly watered by means of artesian wells.

Concerning the fertility of lands composed chiefly of deep deposits of muck, the early idea, based on their limitless supply of vegetable matter, has had to be modified. It was at one time supposed that swamp muck was in itself a fertilizer and desirable to use in large quantities on the higher lands adjoining. But it is found that the benefit from the use of muck in this manner is very slight, not repaying the trouble of applying it, except when composted with barn yard or some other fermentable manure.

Recently it is being noticed that the productiveness of these muck lands is less permanent than was at first supposed, in fact, that after growing a few excellent crops the yield often declines in an alarming manner, more rapidly, in fact, than on surrounding lands composed of the ordinary soil materials.

The question therefore of maintaining the fertility of these cultivated swamps is a problem of immediate interest, the solution of which will have an important bearing on the further development of such lands in this state. So far, the only means employed to any considerable extent for restoring the fertility of exhausted muck lands has been barn-yard manure and, strange as it may perhaps appear considering its highly vegetable and nitrogenous character, this has thus far given entirely satisfactory results. But the application of this fertilizer is necessarily limited and only practicable within reach of cities and villages. Careful and extended trials of other fertilizers are needed. If the application of lime, for example, to these lands shall prove as generally useful in our climate as in the cooler and moister climate of Great Britain the presence of the inexhaustible supply of this material within the state will prove particularly fortunate.

Another class of soils in our state, much less promising than these muck swamps, is found in the northern portion of the Lower Peninsula and consists of extensive sandy plains, covering the larger part of several counties and locally known as "pine barrens." These lands have never been heavily timbered and in recent years have been frequently traversed by forest fires, so that but little humus or vegetable matter remains in the soil. For ordinary farm crops they are in their present condition worthless, as hundreds of abandoned farms in this region, some of them well fenced and with good buildings, too clearly testify. On some of these lands huckleberries, blackberries and other wild fruits grow spontaneously, so that the cultivation of certain of the small fruits thereon would seem to be suggested as a field for experiment.

The tendency in the horticultural development of the state at the present time is northward, and there are fortunately in northern Michigan, in both Upper and Lower Peninsulas, abundant supplies of land suitable for horticultural purposes.

It is probable that the culture of the peach and grape have nearly reached their northern limit, but there is reason to believe that throughout almost the entire Northern Peninsula many varieties of apple, plum, cherry, and small fruits may be grown to great perfection, to supply not only the growing markets in that section of the country, but also to prolong the season of supply for more southern markets.

The limestone formation which prevails about the Straits of Mackinac seems particularly well adapted to the cultivation of many of the finer fruits. Remains of numerous Indian apple orchards, some of them still in bearing condition, may be found throughout this region. Wild fruits of various species grow here in great profusion. Huckleberries in large quantities are annually shipped from Cheboygan and neighboring ports, and other wild berries which grow there in equal abundance might also find a market if they possessed equally good shipping qualities. I have seen wild blackberries of the finest flavor brought into market at Petoskey by the Indians as late as November, but too soft and too carelessly handled to bear distant transportation.

The red raspberry (*Rubus strigosus*) grows and bears abundantly in all this region but the fruit is shipped away only for the purpose of making brandy. The essential hardiness of this species is indicated by the fact that upon the north shores of Lake Superior, where the timber has been swept away by forest fires, there may be seen thousands of acres covered with it. There would appear to be no reason therefore why cultivated varieties of the red raspberry having suitable market qualities might not be successfully grown throughout the whole of northern Michigan.

Plums also are being grown with success in some parts of the Upper Peninsula, where wild plums of excellent quality are occasionally found. Northern Michigan is particularly adapted to the growth of plums by reason of the absence of the rot which is often disastrous to this fruit in warmer climates. The curculio and black knot are also thus far less destructive there than farther south. For these reasons plum growing in that region is likely to see greater development.

Of the peculiar advantages of Michigan for the pursuit of horticulture we are doubtless well convinced, but success depends mainly on the adaptation of the different crops to the required soil and location—and no state has these conditions in greater variety than our own. The last edition of the Michigan fruit catalogue shows that varieties which are considered valuable in one locality are not always grown with success in other localities, often but a short distance away. Thus, such thin-skinned peaches as Mountain Rose and Old Mixon, which are favorites in the moist climate of the Lake Shore, cannot be grown successfully in the peach growing regions of the interior of the state which have a drier climate. The vigorous Late Crawford, which often fails to bear well on the Lake Shore is much more productive, and a favorite market variety inland wherever it proves sufficiently hardy. The slow-growing Hill's Chili, on the other hand, which in the dry interior points fails to bring its heavy load of fruit to perfection, gives entire satisfaction in western Michigan. It is frequently the same with other fruits and with vegetables. The Taylor raspberry, which cannot be grown to advantage in Washtenaw county on account of the drouth, is a desirable sort along the lake shore. The Gregg raspberry, which is almost the only market sort in the above county, gives place in a measure to more productive but less vigorous varieties in other parts of the state. Cauliflowers, which on suitable soil may be grown on upland in western and northern Michigan, are a reliable crop only on reclaimed swamps in the central and southern parts of the state. Much remains to adopt the various horticultural crops to the local conditions found in the state, and fruit and vegetable growers are fully aware of the necessity of understanding the influence of their local conditions. But while these minor adjustments are still going on and are far from complete, the broader lines are better understood; the hills are being devoted to fruit, the reclaimed swamps to vegetables, and the fertile plains are left for the purposes of general agriculture.

## FUTILE EXPERIMENTS FOR THE IMPROVEMENT OF AGRICULTURE.

BY MANLY MILES, M. D.

(Read before the Academy, December 27, 1894.)

[Abstract.]

In the popular demand for experiments to develop and establish correct principles in farm practice, the limits of experimental methods in the advancement of science, and especially in the application of science in agriculture, are entirely overlooked.

The established principles of science may be successfully applied to explain the results of farm practice, while many of the problems presented cannot be solved by direct experiment.

In pointing out the futility of empirical experiments for the discovery of the underlying principles of farm practice we do not belittle or undervalue the advantages of the legitimate applications of science to agriculture. The farmer is constantly dealing with the forces of nature, and a knowledge of the laws that determine and give direction to their various manifestations cannot fail to be of practical value in his every day work.

Investigations in pure science must then be looked upon as the most direct and efficient means of progress in the improvement of agriculture, and the short cuts or royal roads to exact knowledge that are marked out ostensibly for the farmer's benefit must lead him astray out of sight of the landmarks of real progress.

The same lines and methods of research cannot be followed in the different departments of science from the marked difference in the conditions and problems presented for investigation. Physics and chemistry are emphatically experimental sciences, as their fundamental principles and progress and development, from the very nature of the phenomena with which they deal, must depend upon exact experiments in research and for the purposes of verification. In astronomy and biology on the other hand there are insuperable difficulties in the application of experi-

mental methods of research, and they must largely depend upon the critical observation of phenomena as they occur for their progressive development.

In nearly all of the problems requiring investigation in agriculture biological activities are the dominant factors concerned in the reactions of matter and transformations of energy, and the complexity of the conditions presented is intensified by the involved interdependent relations of the biological, physical and chemical factors that cannot be separately investigated.

Our knowledge of the life history and habits of organisms, and the development, morphological relations, and functions of mere organs of nutrition and reproduction has been derived almost exclusively from the observation of the various forms of life under normal conditions, and there is an obvious limit to the application of exact experimental methods from the interference of the required artificial conditions with the normal activities of the organisms that are the subject of inquiry.

The heredity of acquired characters is generally accepted as a fundamental principle in the improvement of domestic animals, and culture and heredity are looked upon as the essential factors in the improvement of the pure breeds.

On theoretical grounds the followers of Weissman claim that acquired characters are not inherited and it is proposed to test the truth of their assumptions by an appeal to direct experiments. There are however insuperable difficulties in the way of the application of this method. There are many diverse characters inherited by each individual, and the frequently observed facts of atavism indicate that no limit can be assigned to the inheritance of ancestral characters.

There is a decided preponderance of evidence in favor of the view that all characters of all ancestors are inherited, and that the dominant or obvious characters may obscure less pronounced characters that may remain latent for many generations until favorable conditions of habit or environment bring them to the surface as dominant characters.

In the inheritance of an acquired character it is obvious that modified functional activities must precede morphological changes, and this explains why the results of accidents are not inherited.

The incipient indications of the inheritance of an acquired character must be manifest in functional changes of the organism that are not as readily observed as morphological changes. An acquired character might be inherited and transmitted for several generations without being noticed, as it would at first in all probability be obscured by the dominance of some well established ancestral characters. The history of the improved breeds and the observation of breeders furnish better evidence in regard to the laws of heredity than can be obtained by direct experiment.

Similar difficulties arise in field and feeding experiments, so far as the discovery of principles that can be profitably applied in practice are concerned. The conditions presented are too complex to permit of the isolation of the various factors involved to determine their real significance as required in exact methods of research.

Experiments to determine the relative nutritive value of foods are fallacious from the number of variable factors involved in the problem that cannot be measured or brought under control, so that it is impossible to determine their relative or combined influence on the results obtained.

The appetite and previous habits of the animals consuming the food, the amount eaten, and the efficiency of their organs of nutrition in performing the work of digestion and assimilation must be recognized as modifying factors that are quite as important in determining nutritive values as the composition of the food itself, and it is evident that experiments cannot be repeated under the same precise conditions for the purpose of verification.

The chemical composition of foods cannot be made to represent their nutritive value, as there are physical and biological factors that are quite as significant. Liebig's false theory that the nitrogenous constituents of foods (proteids) were exclusively used in the building of tissues, and that the non-nitrogenous constituents were burned in the system to produce animal heat, has been a fruitful source of error in planning and conducting feeding experiments. Carbon and oxygen and the ash constituents of food are quite as important factors in tissue building as nitrogen to which attention is almost exclusively directed, and food constituents are not burned in the system to produce animal heat.

The law of the conservation of energy is as strictly observed in organic processes, as in the reactions of inorganic matter, and the transformations of energy in the economy of living organisms are now attracting the attention of physiologists as the most significant results of the metamorphoses of matter. Work must be done in the building and repair of tissues, and the energy so used, derived from the food consumed, is stored up in the organic substances formed. In the destructive metabolism that follows from the wear and tear of tissues in their functional activities, this stored energy is liberated and what is not immediately required in the constructive processes of the system appears as animal heat.

No general statement in regard to the nutritive value of foods can be formulated from the results of experiments in which the chemical factors are alone considered and Liebig's classification of foods has not the physiological significance claimed for it. The same animal may give quite different results with the same food at different times, and different animals are not likely to agree in the returns given for the same food under the same conditions.

From the complex processes of soil metabolism and the various conditions that have an influence for good or ill on the well being of the plants themselves, and the micro-organisms concerned in the elaboration of plant food it may be readily shown that the sources of fallacy are quite as evident in field experiments as in the feeding of animals. In both cases the farmer is dealing with living organisms that thrive best when fully satisfied with the conditions in which they are placed. In nearly all problems that arise in these departments of his calling the farmer will be best aided by researches in pure science for the increase of knowledge relating to the facts and principles of biology.

# THE UREDINEÆ OF MICHIGAN.

BY HARRIET L. MERROW.

(Read before the Academy, December 27, 1894.)

[Abstract.]

One hundred and fifteen species of Uredineæ are enumerated by the writer, the specimens in each case being referred to the herbarium where the specimen recorded is to be found. The date of collection, the parts of the host attacked, and the effect on the host, when that could be observed, are recorded. The writer calls attention to various observations of ecological interest, describes as forms that have escaped notice in systematic works the uredo spores of Uromyces Howei, Pk., Uromyces pisiformis, Cke., and Uromyces Sparganii, C. & P., records the collection of the rare (in this latitude) Ravenelia epiphylla (S) Dietel in Jackson county, Mich., and adds important notes on distribution.

# SECOND ANNUAL MEETING, DECEMBER 1895.

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The second annual meeting of the Academy was held in the pioneer room of the Capitol at Lansing on Thursday and Friday, December 26 and 27, 1895, President Bryant Walker in the chair.

The first session, Thursday, 3 p. m., opened with about twenty members present and the attendance increased during this and the subsequent sessions to a maximum of about sixty, many of the members being absent from the sessions of the Academy much of the time in necessary attendance on the meetings of the State Teachers' Association, which also was in session.

The treasurer's report showed the finances of the Academy to be in a satisfactory condition, with a balance of about $86.00 on hand.

At the beginning of this meeting the membership roll bore the names of 106 resident members and three corresponding members. Twelve new resident members were elected on December 26, and one on December 27, thus increasing the number to a total of one hundred and twenty-two. The new members were:

Arthur G. Baumgartel, Holland.
A. H. Boies, Hudson.
Geo. H. Cattermole, M. D., Lansing.
Myron T. Dodge, Saginaw, E. S.
Edgar G. Haymond, Flint.
John Hazelwood, Port Huron.
Frederick Chas. Irwin, Bay City.
William Jackman, Iron Mountain.
W. A. Oldfield, Port Sanilac.
Chase S. Osborn, Sault Ste. Marie.
*James B. Purdy, Plymouth.
Julius O. Schlotterbeck, University of Michigan, Ann Arbor.
Norman A. Wood, 19 Church St., Ann Arbor.

The officers elected for the ensuing year were as follows:

President—William H. Sherzer, Ypsilanti.
Treasurer—Charles E. Barr, Albion.
Secretary—Walter B. Barrows, Agricultural College.
Vice Presidents—Botany, F. C. Newcombe, Ann Arbor; Zoölogy, J. E. Reighard, Ann Arbor; Sanitary Science, Henry B. Baker, M. D., Lansing.

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*Declined membership.

It was voted to recommend to the Council that the next winter meeting be held at Ann Arbor during the spring vacation of the public schools of the State, in 1897.

Notice was given by Prof. C. E. Barr of intention to ask at the next regular meeting for changes in the constitution and by-laws, as follows: Striking out of Article IX of the constitution the words "provided that notice of the proposed amendment shall have been given at a previous meeting;" and striking out of Chapter IX of the by-laws the words "provided that notice of the substance of the proposed amendment has been given at a previous meeting."

The following resolution was adopted:

"Resolved, That the Section of Zoölogy be hereby directed to take such means, by securing proper legislation or otherwise, as will more effectually preserve the useful and harmless birds of the State."

Notice was given of intention to organize a Section of Agriculture under the rules prescribed by the constitution and by-laws. Eleven members signified their intention of joining this section.

The following resolution, introduced by Dr. W. J. Beal, was referred to the Council:

Resolved by the members of the Michigan Academy of Science, That we are earnestly in favor of a law similar to one enacted in 1887, providing for a State Forest Commission, and that we hereby pledge ourselves to see that the next Legislature carry out our views on this important subject.

PAPERS PRESENTED AT THE SECOND ANNUAL MEETING OF THE MICHIGAN ACADEMY OF SCIENCE, DECEMBER 26 AND 27, 1895:

1. The Origin and Distribution of the Non-Marine Mollusca of North America. Mr. Bryant Walker. (Presidential Address.) Printed in full in this report.

2. The Evolution of Conventional Decorative Forms. Mr. Zach. Rice.

3. The Sub-carboniferous Limestone Exposure at Grand Rapids. Mr. Chas. A. Whittemore. Printed in full in this report.

4. The Significance of Results in Dairy Stock-Feeding Experiments. C. D. Smith.

5. Some Plans for a Botanic Garden. Dr. W. J. Beal. Printed in Rep. Secy. State Board of Agr., 1895, pp. 51-76.

6. Notes on the Seismic Disturbances in Missouri, Oct. 31st, 1895. Mr. John M. Millar. Printed in full in this report.

7. Michigan Birds that Nest in Open Meadows. Mr. L. Whitney Watkins. Printed in full in this report.

8. Sulfur and Celestite in Monroe County, Michigan. Prof. Wm. H. Sherzer. Printed in Am. Jour. Science, New Series.

9. Recent Advances in Agricultural Botany. A. A. Crozier. Unpublished. Copy never in hands of the Secretary.

10. Work which may be done by the Non-Professional Observer to assist the Michigan Geological Survey. Dr. L. L. Hubbard. Unpublished.

11. The Needs of Michigan Forests. Dr. W. J. Beal. Printed in Rep. Secy. State Board of Agr., 1895, pp. 51-76.

12. Food Habits of Michigan Birds. Prof. Walter B. Barrows. Published in part, under the title "Birds and Horticulture," in Report of Secy. Mich. State Hort. Soc., 1895, pp. 127-132.

13. New Species of Plants for Michigan, and New Localities for Old Species. Mr. O. A. Farwell. Published under the title "Contributions to the Botany of Michigan" in the Asa Gray Bulletin, Vols. II and III, 1894, 1895.

14. An Unpublished Paper on the Geology of Western Michigan. Dr. Alexander Winchell. Unpublished.

15. Preliminary Notes on Trillium grandiflorum. Prof. Chas. A. Davis. Abstract in this report.

In addition to the fifteen papers listed on the printed program, two others were presented, namely:

16. On the Smallest Parts of Stentor Capable of Regeneration. Dr. Frank R. Lillie. Printed in Journ. of Morphology, Vol. 12, May, 1896, pp. 239-249.

17. The New Science of Sanitation. Dr. Henry B. Baker. Printed in this report.

# THE ORIGIN AND DISTRIBUTION OF THE LAND AND FRESH-WATER MOLLUSCA OF NORTH AMERICA.

BRYANT WALKER, DETROIT.

(Address of the Retiring President of the Academy, delivered Dec. 26, 1895.)

The origin of life has been a favorite topic for thought and discussion among the philosophers from the earliest times, of which we have any literary records. From the time when the mere struggle for existence ceased to occupy the whole attention of primitive man, and the advance of civilization afforded the leisure and opportunity for intellectual life, the great problem of its own existence, and that of the world around it, necessarily obtruded itself upon the thoughtful mind.

There is scarcely a race or tribe of mankind, except perhaps those in the very lowest stages of barbarism, who have not, at least some legend or tradition as to the creation of the world and its inhabitants, and with every advance in civilization there has been a corresponding widening of the intellectual horizon, which has enabled the successive generations of man to put aside the crude imaginings of the savage for the adoption of a better and more rational system of natural philosophy. The evolution of a world's philosophy must always be a subject of the greatest interest, and when the complete history of human knowledge comes to be written, there will be no chapters exceeding in interest those, which shall elaborate the rise and development of those great laws of science, art, politics and religion, which are today considered to be the fundamental principals of our modern civilization.

In the centuries which lie between Thales of Ionia and Darwin of England, much has been written and many theories have been advanced upon the origin of life, only to be thrown aside again by each succeeding school of philosophy. And today, after twenty-five hundred years of speculation and research, the question of origin of the ultimate principle of life—the vital essence—is, from a scientific point of view, still unsolved and apparently insolvable. But while the speculative minds of the nineteenth century are still groping and grasping unsuccessfully for the same will-o'-the-wisp, which danced before the Ionian philosophers half a millennium before the Christian Era, there are others and more practical phases of the question, to which the science of today believes it has the key, and which can be made to yield their mysteries to the patient seeker after scientific truth.

The origin, not of life in the abstract, but of the manifold and varied forms of animated nature, which now and in ages past have peopled the world, is the fruitful field in which modern science has won her choicest triumphs.

The speculation of the early Greek philosophers in this subject, while they may seem crude and too often absurd to our modern eyes, are remarkable in many instances for their keen insight into nature and their foreshadowing of those great principals of evolution and design, which today mould the thoughts of the scientific world. Broadly speaking, however, the natural philosophy of the Greeks was wiped out under the mental glaciers of the dark ages and prior to the time of Linnæus, the origin and distribution of animal life was a closed book sealed by ecclesiastical anathema to any one, who might have desired to read therein. The doctrine of special creation, which was almost universally accepted in the eighteenth century, was the necessary and inevitable result of a prevalent and powerful theological scholasticism, which pervaded and controlled all the great centers of intellectual life.

To Linnaeus and his school there were "as many species as issued in pairs from the hands of the Creator." Specific creation was the origin of all forms of life, and every species lived in the place appointed for it by the wisdom of the Omnipotent. The termination of each of the great geological epochs was signalized by a general massacre of all existing forms of life, and the advent of the new era was signalized by the creation of a new fauna specially adapted to the peculiar conditions of the new world.

To such a philosophy, "the structural relations found to exist between the fossil forms themselves, and between the fossil and living forms are meaningless and unimportant," and all speculations as to the reason for the many apparent anomalies and excentricities found in the distribution of life at the present time are not only useless, but even blasphemous. The publication of the "Origin of Species" in 1859 marked an epoch in the intellectual history of the world. Whether the evolutionary theory and the means by which it has operated be true or not, there can be no question, but that its general acceptation as a working hypothesis has done more to stimulate scientific work, and to increase the sum of human knowledge than any other factor in the history of science.

The adoption of the Darwinian postulates that "the several species of the same genus, though now inhabiting the most distant quarters of the world, must originally have proceeded from the same source, as they are descended from the same progenitor" and that "individuals of the same species, though now inhabiting distant and isolated regions, must have proceeded from one spot, where their parents were first produced," necessarily involves the careful and systematic study of the distribution of animal life from its earliest appearance to the present time. If the theory of evolution be true, there must be an adequate explanation for the present existence of every species where it is now found. In the comparatively few years that have elapsed since this door of research was opened, under the stimulating influences of the new doctrine, much has been done in that direction. Indeed when it is considered that successful investigation in this direction involves:

1st. A comparative knowledge of the existing faunas of all the different countries of the world.

2d. A true and natural classification of the animal kingdom.

3d. A consideration of the methods of dispersal and of the barriers which prevent it; the effects of changes in physical geography and climate and the various modes in which such changes affect the structure, distribution or the very existence of faunal life, and

4th. As the existing distribution is the result and outcome of all preceding changes of the earth and its inhabitants, a knowledge of the animals of each country during past geological epochs, their migrations during the various ages and the changes of physical geography that they imply—the wonder is that so much has been accomplished up to the present time.

In no department of Zoölogy has better work been done than in the mollusca and it is to a review of what has been accomplished towards the elucidation of the origin and development of the existing non-marine molluscan fauna of our own country, that I ask your attention this evening.

North America, north of Mexico, has usually been considered as a distinct Zoölogical province, and forms the Nearctic Region of Wallace and other earlier writers on the subject. It corresponds with the Palæarctic Region of the old world, which embraces Europe, the Northern part of Africa and Asia, north of the Himalayas. Later writers, on the ground of "the absence of both positive and negative faunal characters of sufficient importance to separate them from each other," have combined these regions into one, extending around the entire northern part of the globe under the name of the Holarctic Realm. Be this as it may, when viewed from the standpoint of the zoögeographer, whose generalizations are based upon the fauna of all classes taken as a whole, it must be admitted that from the standpoint of the conchologist, the fauna of North America has many features, which stamp it with all the indices of a peculiar region. Indeed under either scheme, the subprovinces are substantially the same. The main difference being, that the Northern Province, so called, of America, is combined with the corresponding region of the old world, into a single circumpolar region, as the remaining subprovinces or regions remaining the same. With this distinction in mind, it will be convenient, for the purpose of this paper, to follow substantially the arrangement of Binney who, in studying the terrestrial mollusca, divided the continent into four regions—The Northern, Interior, Californian, and Central.

The Northern or Boreal Region comprises the entire northern portion of the continent. Its southern border is not clearly defined. It has been stated to be approximately fixed by the northern limits of the cultivation of the cereals, and "may be indicated in general terms as the same with the political division between the British possessions and the United States, to the northeast corner of New York, where it runs southeasterly along the Appalachian chain of mountains to Chesapeake bay."

The Interior, or Appalachian Region, includes the entire eastern portion of the continent, south of the Northern Region, and east of the Sierra Nevada and Cascade mountains. From this, however, on the south, may be separated such portions of Florida, Texas, Arizona, New Mexico, Nevada and California, as from the admixture of tropical forms seem better included in the Transition Region, so called, lying between the Holarctic and Neotropical Realms. This includes the Southern Region of Binney. The Central or Rocky Mountain Region, lies between the Sierra Nevada and Cascade mountains on the west, and the Rocky mountains on the east. While the California or Pacific Region, comprises the entire coast lands of the Pacific, west of the Rocky mountains, and extending from Lower California to Alaska.

The exact boundaries of these regions are often more or less indefinite, except where natural barriers of ranges of mountains, deserts or great bodies of water exist. And, in the absence of these, they seem often to overlap along their borders, owing to the eccentric distribution of many species, resulting from peculiar local conditions of climate, temperature, etc. In the main they are well characterized by the peculiarities of their respective faunas. Thus in regard to the land shells the Northern Region is entirely deficient in the larger Helices, which seem unable to withstand the extreme vigor of the climate, and is peopled by a multitude of smaller forms such as the *Zonitidæ* and *Pupidæ*, whose greater tenacity of life has enabled them to occupy an enormous territory to the exclusion of their larger and more sensitive brethren. Not only have these genera possessed to themselves the entire Boreal Region proper, but they have extended south in all directions. Many of them are now cosmopolitan in the broadest sense of the word, having an almost world wide distribution, while others, following the lines of the great mountain chains, have found congenial homes all along the extent of the eastern and western highlands. That the extension of these forms into the southern provinces has been from the north rather than from the east or west is shown by the fact that in neither direction have they been accompanied by the species peculiar to the eastern and western regions, as there is little doubt they would have been had this latter hypothesis been true.

The Interior Region, which as above limited includes the greater part of the United States, is characterized by a large and abundant fauna, both in species and individuals, which is purely indigenous in its character. With the exception of a few species which have effected a lodgment in some of the West Indian islands, or wandered southerly into Mexico, and a stray colony located in the Californian and Central Regions in the northwestern part of the United States, the great genus known as "*Polygyra*" is peculiar to eastern North America. Its species are essentially forest loving and consequently rapidly diminish as the deciduous forests disappear toward the north, and with the exception of a limited number of the more hardy forms it is not represented in the dry arid regions of the western states.

The Californian Region is the home of a large and beautiful group of species very different in appearance from the somber-colored denizens of our eastern forests, and strikingly similar to the Helices characteristic of the northern parts of Europe and Asia on one hand, and of Central America and Western South America on the other.

The Central Region, which includes the dry and elevated region lying between the Rocky and Sierra Nevada ranges of mountains is, as might be expected from its physical peculiarities, very destitute in the number of its mollusca. But these, such as they are, barring the small forms, which have crept in from the north and some of like genera, but specifically peculiar to the Californian Region, which have been able to surmount the mountain barriers, are generically related to forms peculiar to the Interior Region. They are not true *Helicidæ*, however, but belong to a more primitive stock, of wide range through the entire Boreal Region. Neither the peculiar Helices of the Californian Region, nor the authocthonous species so widely distributed through the Interior Region, seem to have been able to surmount the mountain ranges which separate it on either side.

In regard to the existing fluviatile fauna of North America, while in the main the regional limits above defined hold good, yet in many cases the barriers, which seem to have been sufficient to determine the range of the land species, have apparently been overcome or, at least, do not apply.

Thus the fresh water pulmonate families, while they have their metropolis in the north, like the land species peculiar to the Boreal Region, probably from greater powers of endurance and greater adaptability to environmental changes, and possibly also from the greater facilities for migration afforded by the medium in which they live, have a wide distribution. Thus while the region of the Great Lakes and the St. Lawrence drainage system has the largest collection of species, yet there is not a state in the Union that has not some representatives of nearly every genus, and some species can be found in nearly every state. Indeed these genera have spread over the whole world, and some species are not only circumpolor. but almost cosmopolitan in their range.

These forms have been, almost everywhere in this country, also accompanied by certain genera of small operculate mollusks, such as *Valvata* and *Amnicola*, etc. As has already been stated in regard to the distribution of the boreal land species and for similar reasons, the present range of these forms was undoubtedly effected from the north to the south.

In the operculate family of the *Pleuroceridæ*, or American melanians we have, as in the *Polygræ* among the land snails, a group of wholly American origin and one surprisingly like that in its distribution. Of enormous abundance (Tryon's monograph, 1874, containing 464 species) in the prolific rivers draining the lower parts of the Appalachian chain. where it exists in such an infinite variety of forms as to almost do away with any attempt to define specific limitation, it has spread out in all directions. The great majority of these species are confined to the rivers flowing from the Cumberland mountains and in these they are generally confined to the upper portions as they are particularly partial to rapidly flowing streams with rocky bottoms. On the west the Mississippi river seems to have been a barrier and but few species are found in the states lying west of it. Curiously enough a colony of detached species of peculiar aspect is found in the Californian Region, a circumstance analogous to the group of Californian *Polygyræ* already mentioned. A remarkable genus of this family, *Schizostoma*, embracing nearly thirty species, is confined to the Coosa river in Alabama. To the north but few species have extended beyond the Ohio; a very few reach into the rivers tributary to the great lakes—thirteen species being found in Michigan. From Virginia to the north, the Appalachian range has proved an effective barrier against immigration into the Atlantic states. New England has no representative of the family. A single species of *Goniobasis*, which singularly enough is not found west of these mountains, and a species or two of *Anculosa* are the only representatives in eastern New York and Pennsylvania.

The remaining family of operculate mollusks represented in our fauna, the *Viviparidæ*, which includes the larger forms usually met with, is also peculiar in its distribution. The typical *Viviparæ* have a widespread range in the Northern Hemisphere, being well represented in Europe, and exceedingly abundant in Southern and Eastern Asia. A curious example of local development may be mentioned in connection with this genus. The species are many of them ornamental with transverse bands of green or brown. In such case, all European species have three bands, the American four bands and the Asian are multilineate. There is no exception known to this rule. The American forms are closely related to the European, and indeed in the case of the two more common species in these countries, the difference in the number of bands is almost the only distinguishable characteristic. Curiously enough, although the European species are found in England, and, at least, one American form extends as far north as Minnesota, the family is wholly wanting in the Pacific states, whose fauna in many other respects is more closely allied to that of the old world than that of any other part of this continent. In addition to the true Viviparas we have three genera peculiar to North America. One, *Campeloma*, is of almost universal extent throughout the Interior Region. Another, *Lioplax*, has only two species. One abundantly extended through the Mississippi valley and the other confined in the Coosa river in Alabama. While the third and most remarkable of all is its bizarre appearance, *Tulotoma*, is confined wholly to the upper portion of that river.

Passing now to the bivalves, we find in the enormous development of the *Unionidæ* by far the most striking feature of our fauna. No less than 645 species of this family are catalogued by Lea in his last synopsis. While the increase of our knowledge of the great amount of variation exhibited by this family under local influences has already resulted in the diminution of recognized species and the future will undoubtedly increase the result, the enormous and peculiar development of this family, particularly in the southeastern portion of the United States, forms with the *Polygyræ* among the land shells, and the *Pleuroceridæ* among the fluviatile univalves, the distinguishing features of our fauna. The distribution of these forms over the continent is general. That is, there is no portion affording a suitable habitat that is without some representative of the family, yet the limitations upon the distribution of many of the various groups of species, and even upon individual forms are well marked and often very remarkable, and offer to the inquiring mind many problems for investigation. In the main, there are substantially what may be called four sub-faunas represented. The great lines of archean rocks now known as the Sierra Nevada range on the west and Appalachian on the east have proved to be almost impassable barriers to the dispersion of this family, and the existence of the distinct faunas separated by these ranges is conclusive proof that they antedate the origin or the immigration of the forms peculiar to them. The California Region so peculiar in its land species is equally well characterized by its unione fauna. The great genus *Unio*, which is represented in the Eastern States by more than 200 species in Alabama and 40 in Michigan, is wholly wanting west of the Rocky mountains, this being the largest area destitute of unio life in the temperate or tropical regions of the globe. The only *Margaritina* is a European species of circumpolar range. While the Anodontas belong to a peculiar group entirely distinct from those found in the eastern states, and so closely allied to the prevalent palæarctic type, that by eminent conchologist they have considered no more than a geographical race of a well known European form.

In the same way east of the Appalachian Range, is a group of distinct species extending along the entire Atlantic coast from the extreme north to Florida. In the Boreal Region some of these forms have a wide range to west extending as far as Manitoba, if not further, and from this region some of them have acquired a considerable range into the states south of the great lakes. As a whole this fauna has closer relations with the Californian and Eurasian fauna than with the species peculiar to the interior region of this continent. Thus the European *Margaritina margaritifera* is common to both the Pacific and Atlantic states, but curiously enough is wholly wanting in the broad territory lying between them. The Anodontas are also very similar to those of California, but are sufficiently different to be generally accorded specific distinction. The Unios while peculiar to the region have no relation to the European forms, and as already stated, this genus does not occur in the Californian Province at all. In the immense region comprising the greater portion of the continent lying between these narrow coast provinces is to be found an exuberance of Unione life, as is without parallel in any other portion of the world. Here under the kindly influences of what must be a peculiarly favorable environment, are to be found a multitude of species which in size, shape and manner of ornamentation exhibit almost infinite variety, and which nevertheless are throughout stamped with such local peculiarities that to even the tyro in conchology, no label is needed to indicate their fatherland.

But even in this great assembly of similar, yet dissimilar forms, there can without difficulty be distinguished two great races, or faunal groups. The one, and by far the larger one embracing the massive triangular, plicate and nodulous forms, which are distinctly North American types, has its headquarters in great valley of the Mississippi and from thence has spread out northerly into the St. Lawrence valley and southerly into the rivers of Texas and Alabama.

To the southeast, however, it is to a large extent replaced by a numerous group of smaller and plainer species which, as though from a metropolis in the mountains lying between Tennessee, Alabama, the Carolinas and George, has peopled the mountain streams on either side, east toward the Atlantic and south and west to the Gulf with a multitude of forms whose susceptibility to local influences has played almost as much mischief with current standards of specific distinction as their neighbors and associates, the *Pleuroceridæ* from the same region.

Besides the *Unionidæ*, there is but one other family of bivalve mollusks represented in our existing fauna. The *Cyrenidæ* represent a large number of species of small size (the largest being one-half inch and the smallest less than one-fifteenth of an inch in its greatest diameter) of general distribution. Some of them indeed ranging over nearly the whole continent. Like the *Limnæidæ* among the univalves, it reaches its maximum development in the north, and from thence has apparently extended southward in all directions. As a necessary consequence the great mountain ranges, which have so effectively limited the range of the *Unionidæ* have apparently had no influences in determining the range of these little species.

Passing now from the consideration of the distribution of the various orders and families represented in our fauna and collating the details of their distribution in order to get a general idea of the leading features of our fauna, as a whole we find that both among the land and fluviatile species evidence, which is substantially the same in both classes, tending to show the existence of three separate faunas, which though in their present distribution more or less overlap each other, nevertheless are essentially distinct.

Thus we find the Boreal Region, which is substantially coincident with British North America, while lacking almost entirely the larger and more highly organized Helices, the *Viviparidæ*, the *Pleuroceridæ* and the characteristic types of North American *Unionidæ*, is the metropolis of the *Zonitidæ*, *Pupidæ* and *Succineidæ* among the land shells, the *Limnæidæ* and *Physidæ* comprising the fresh water pulmonates the *Rissoidæ* and *Valvatidæ* in the operculates and the *Cyrenidæ* in the bivalves. These families comprise the greater majority of the smaller species of mollusca represented in our fauna and, as already stated, from this broadly extended home in the north, aided no doubt by their hardy nature and greater vitality and consequent greater ability to adapt themselves to vicissitudes incident to changes of environment, many of them have succeeded in establishing themselves in nearly every portion of the continent. Associated with these groups are certain of the *Unionidæ*, which ranging nearly across the continent in the north do not occur south of the great lakes west of the Alleghaney mountains, but east of that range occupy the entire Atlantic drainage to the almost entire exclusion of other forms. This apparent extension of the Boreal Region along the entire Atlantic coast, may at first sight seem anomalous. But when it is considered that these mountains, while offering no obstacle to immigration from the north, have formed an almost insurmountable barrier to the incursion of the species of the Interior Region from the west and that thus the region has been left open to the exclusive occupation of the northern forms, the explanation is so obvious as to be almost self demonstrative. In the same way we find that west of the Sierra Nevada along the entire Pacific coast, a peculiar fauna, which apparently for the same reason has never extended itself toward the east. Excluding the species which have crept in from the north, the Californian fauna in many of its features is quite as different from that of the eastern portion of the continent, as that is from the fauna of northern Europe.

The fauna of the Central Region both land and fluviatile, is too sparse almost to be considered. Its claims to regional distinction are based almost wholly upon its negative rather than any positive characteristics. It is wanting in the distinctive forms, both of the Californian and Interior Regions. Its distinctive land shells belong to a group characteristic of the Boreal Region. A few fresh water species are peculiar and are probably the last existing local remnant of the abundant fauna which existed there in tertiary times.

The Interior Region, lying between the great eastern and western mountain ranges, is the only one which, in its mollusca, exhibits any of the peculiarities of a great continental fauna. Here are found the exclusively North American genera of *Polygyra* among the land species and *Campeloma*, *Tulotoma* and the several genera of the *Pleuroceridæ* among the fluviatile univalves and the extraordinary development of the *Unionidæ* already mentioned. The greater part of this enormous fauna is found south and east of the Ohio and Mississippi rivers. A few of the hardier species of *Polygyra* have extended north to the limits of the deciduous forest, while the more favorable conditions of temperature and moisture along the south Appalachians has enabled a number of species to extend their range into the Southern Atlantic states.

In a similar manner some species of *Campeloma* and *Goniobasis* among the Univalves and *Unio* and *Margaritina* and *Anondonta* among the bivalves, have spread out to the northern reaches of the Missouri and Mississippi and even into the St. Lawrence drainage and from thence into the waters of eastern New York and New England.

Toward the south a few of the species range into Mexico and Central America where they mingle with the northern outposts of the tropical fauna of South America. And in a similar manner, a few stragglers from the West Indies and South America have obtained a foothold along the gulf states and the Mexican boundary. To Binney, treating the North America fauna as separate entirety, the occurrence of these species along our southern borders justified the establishment of a southern region or province. But a broader generalization based upon the zoölogical relations of the two continents, requires its union with the mixed fauna of Central America and Mexico, which is now considered a transition region between North and South America.

Taken as a whole, however, there is very little in common, so far as the existing mollusca are concerned, between the two great divisions of the New World. Indeed it would not be far from true to say, that not only are there no common species, which would scarcely be expected, but that common genera as well, are almost wholly lacking. In almost every class of molluscan life, the corresponding place in the economy of nature, is filled by radically different groups. Thus the northern indigenous Helices are replaced by the tropical *Bulimuli*, the Viviparas by the Ampullarias, the *Pleuroceridæ* by the *Melaniadæ* and the *Unionidæ* (largely) by the *Mutelidæ* and so on, almost indefinitely. In short the differences are quite as great as between the fauna of North America and Asia. There is one remarkable exception, however, which must not be passed by unnoticed. The peculiar helicoid fauna of the Pacific coast, which is so conspicuously absent from eastern North America, is found not only through Mexico and Central America, but all over South America as far south as Argentina. The importance of this fact as bearing upon the evolutionary history of our fauna will be referred to later.

In striking contrast with this radical separation between the existing faunas of North and South America is the close relationship between those of the great continental areas of the Northern Hemisphere. With the exception of the American melanians and the peculiar polygyrine Helices of the eastern states, not only the families, but the characteristic genera, are in the main the same. The minor groups peculiar to each are but differentiations of types common to both. Moreover, in addition to their general generic resemblance, according to one recent authority, there are no less than thirty-five species common to them all.

These are the great elemental facts of present distribution, and to account not only for them, but for the many peculiarities of the provincial faunas, which have been indicated, upon a basis of acceptable scientific theory, is the problem which is now engaging the attention of all students interested in the study of the origin and distribution of animal life.

Before attempting to present the leading facts and theories which bear upon the origin and introduction of the existing fauna of North America, a few words in regard to the geological history of the continent and its relation to the subject may not be out of place.

By the general concurrence of scientific opinion, the some-time theories of the existence of an Atlantis or other ancient land connection across either the Atlantic or Pacific oceans between the old and new worlds have been put aside as wholly untenable, and "the general permanence of what are now the great continents and deep oceans" is now generally accepted as an established fact. The great changes which from time to time in the world's history have occurred from the constantly recurring submergence of the land beneath the sea and its subsequent unheavals, are believed to have only changed the configuration of the surface of these ancient continents, and from time to time altered their area and extent. There is no reason to believe that, from the time when the dry land first appeared above the surface of the palaeozoic sea, there has ever been a period when any of the great continental areas have been wholly submerged. There has always been a refuge where at least a remnant of the existing fauna has been preserved, that might again under favorable auspices, though with changed surroundings, re-people the earth. But while modern geology fails to bridge the Atlantic and Pacific, it is free to admit what paleontology claims must have been the fact, that at certain periods there has been a land connection between the old and the new world. There can be no doubt but that in ages past there has been from time to time such an elevation in the extreme north as to unite Asia and what is now Alaska.

Whether there has ever been a similar Antarctic continent uniting Africa and South America with perhaps New Zealand is not yet generally admitted. With one exception perhaps, it is a question which has no bearing upon the scope of the present discussion, and it may be passed by with the remark that such an extension of the earth surface is contended for many able authorities, and that it is a hypothesis which would solve some of the most perplexing questions now before the zoögeographers.

As all of the palaeozoic strata are considered to be of marine origin, with the possible exception of the coal deposits of the Carboniferous age, in which are found the earliest known non-marine mollusca, the following account by C. A. White of the United States Geological Survey will be a sufficient statement of the condition of the continent at the time when the non-marine fauna first appeared. "East of west longitude 95° (the western part of the Mississippi valley), North America is mainly occupied by Paleozoic and Archaean rocks, as is also a large area which extends northward and southward through western North America, the eastern border of which is not far from the 113th meridian of west longitude. These two great areas are taken to represent approximately the outline and extent of the principal portions of the North American continent that were above the level of the sea at the beginning of the Mesozoic time. A broad expanse of Mesozoic sea then stretched between these two continental factors, which were finally united by a general continental elevation and the consequent recedence of the sea. This elevation was not—properly speaking—catastrophal, but gradual and oscillatory." Without going into detail in regard to gradual elevation of the continental area, it is sufficient for our present purpose to add, that during the Mesozoic and Tertiary periods this great sea was by the general continental elevation separated from the great open ocean and became first brackish and then fresh water, and finally after the elevation of the Rocky mountains in its midst, was wholly drained off or evaporated, leaving the great western plains of the present day as surface evidence of its former existence. The existence of this great body of water, stretching from what is now the Gulf of Mexico to the Arctic ocean, salt when first separated from the primeval ocean by the continental elevation at the north and south, and gradually becoming a series of great fresh water lakes, is perhaps the most important factor in evolutionary history of our mollusca. For not only in its waters were developed the ancestral types of nearly all of our existing fresh water forms, an almost unbroken series of which, from the earliest Mesozoic times to the present have been preserved in its sedimentary deposits, but as we shall see, it has also played a most important part in limiting the immigration from other regions.

And in connection with this, it must be remembered that the great coast ranges of the Sierra Nevada on the west and the Appalachians on the east have been in existence substantially as they now are from the earliest times, and in this way, must have to no small degree affected not only the distribution of the great faunas of the prehistoric ages, but that of many of our recent species.

The third great factor, which in past ages has influenced the distribution of our molluscan fauna, was the glacial epoch toward the close of the Tertiary period. The advance of the post pleiocene ice sheet, not only wiped out of existence all forms of life, which were unable to escape before it, but the influence of its attendant low temperature extending far beyond the line of the ice itself, absolutely extinguished the great fauna of southern forms which had poured into North America from South America in early Tertiary times, and were unable to withstand the radical change in the climate, the bones of whose gigantic mammals now alone remain to astonish the beholder and to play their part in the elucidation of the world's history. That the gradual advance of the ice must necessarily have sounded the death knell for all animal life through the entire northern portion of the continent, as far south as the valley of the Ohio, can be easily appreciated when it is remembered that its height is estimated to have been, at least, nine thousand feet, and that when it receded it left the lowlands of New England and the northern states buried under a bed of boulder clay and glacial drift from ten to two hundred feet deep. It is estimated by Prof. Newberry that the average depth of the drift in the state of Ohio is, at least, sixty feet.

Upon the recedence of the glacier, the fall of the waters left the surface of the continent as we now find it, and the scattered remnants of the Tertiary fauna along its southern border were enabled to spread out over the new land and to establish the fauna of the continent as it exists today.

More than twenty-five hundred years ago the philosophers of ancient Greece, influenced no doubt by the teeming life, which swarmed in their native seas, taught their disciples that all life came from the ocean, and today the exponent of modern scientific thought can but reaffirm the happy speculation of these wise men of old and assert it as one of the fundamental facts upon which rest the whole structure of the modern science. For, if the accepted theories of the creation of the world and the evolution of the life upon it be true, there can be no doubt that the first land which appeared above the surface of the primordial ocean was peopled from the waters that gave it birth, and that to the marine forms of life must be traced the origin of all existing forms of animated nature. According to Bronn, "the principal change affecting the external conditions of the existence of animal life is to be found in the progressive development of the surface of the earth, in the subdivision of the universal primordial ocean into great inland seas and in the elevation of the plateaus and ranges of mountains. Simultaneously a correlative change manifests itself in the organic world. To the original fauna exclusively pelagic and natatory is added first a deep sea fauna, then a littoral one in the shallow waters, and finally one inhabited exclusively the land." But while this is the accepted theory and notwithstanding the enormous amount of facts, which have been already accumulated to substantiate it, there are yet wanting in almost every department, owing partially to the imperfection of the geological record, and partially to the magnitude of the work involved, many links necessary to complete the genealogy of existing forms of life, and in no class of the animal kingdom is the break as complete as in the phylogeny of the land and fresh water mollusca. The earliest forms of terrestrial mollusks yet known are from the Carboniferous deposits of North America. The fresh water univalves first appear in the rocks of the upper Jurassic, as do also the Cyrenidæ. The Unionidæ do not appear until the lower Cretaceous, although certain forms as yet imperfectly known, but which may be connected with them have been described from the Carboniferous period. But in all cases the families and genera are fully differentiated and substantially identical with those now in existence. And although this fact indicates that these forms must even then have had a long existence in order to have acquired such a high degree of differentiation, there is yet a total lack of the earlier ancestral and more primitive types connecting them with the marine forms. By the study of the embryology, anatomy and morphology of existing forms, we can more or less clearly arrive at theoretical conclusions as to their relations with the marine mollusca and the probable line of descent, and from the habits and mode of life of recent mollusks can postulate theories more or less satisfactory as to the manner in which these great changes were brought about. But more than that is now and will be impossible until the earth shall yield the secret to her inquiring children. But putting speculation aside and relying wholly upon the palaeontological evidences already in our possession, we find that from the time these primitive mollusks first appeared, they have existed in constantly increasing numbers and with a greater degree of specialization in each succeeding epoch. And by a comparative study of the fossil and recent forms both in their phylogenetic relations and their distribution in time and in connection with the theories of the geologists in regard to the successive changes in the earth's surface, we can frequently trace back the history of many of our recent species to remote times and satisfactorily account for their present oftimes seeming erratic distribution. For when the chronological order of the appearance of the different families and genera coincides with the evidence given by their geographic distribution and these are also consistent with the accepted doctrines of geology as to the changes in the earth's surface, which would afford a possibility and opportunity for such distribution, the consensus of all these elements amounts to practically positive proof. With these considerations in mind let us now return to our present fauna and see how far the existing distribution of our mollusca can be explained from the paleontological and geological evidences at our command.

As already stated the earliest forms of terrestrial Mollusks now known are from the carboniferous deposits of our northern United States and Canada. The genera there represented *Pupa* and *Zonites* are indistinguishable from these genera as they exist today. And it is a notable fact that these genera are now not only universally distributed over this continent, but that they have an almost worldwide range over the globe. The vast antiquity of these forms and their present almost universal distribution must be recognized as correlative facts, the significance of which is obvious.

The remarkable and peculiar helicoid fauna of the Pacific coast has also been mentioned. These snails are not entirely different from the eastern American fauna in their conchological characters, but in anatomical features as well, and belong to an entirely different sub-family, which, from its more specialized character, is believed to be of much later origin in time, and whose affinities are wholly with the present fauna of eastern Asia. Without going into the evidence upon which the theory is based, it may be stated there is reason to believe during the time when the great Mesozoic sea divided the eastern Archean continent from the western, there were two successive immigrations of helicoid life from Asia over the inter-continental bridge, which then existed across Behring Straits. The first of these occurred at a very early period, probably in Secondary times. Prevented from spreading to the east by the Mesozoic sea, the invading mollusks spread southward along the Pacific into Mexico and Central America. From thence, one division continued south into South America where today it constitutes a large part of the helicoid fauna. About the same time, or as soon as opportunity was offorded by the elevation above the sea of the land bridge between Central America and the West Indian Islands (which has undoubtedly existed), another division spread eastward and peopled what are now known as the Greater and Lesser Antilles. In this invasion the helices were in all probability accompanied by the ancestral forms of the operculated mollusca now so abundant in that region and by a detached colony of the Clausilias peculiar to northeastern Asia, which found a permanent home in the mountains of Equador and Peru. No remnants of this invasion now exist along its line of travel down the Californian coast and with the exception of a few forms, which later passed from the West Indies into southern Florida, none are found in North America north of Mexico. Whether the failure of these mollusks to effect a permanent footing along the Californian coast, was owing to the fact they were exterminated by some subsequent submergence of that region, or, as suggested by Huxley, that they passed to the south along some continental extension to the west, which is now covered by the Pacific Ocean, cannot now be told. But that was the manner in which one great tribe of mollusks attained in its present distribution in the western hemisphere seems to be justified by the latest and best scientific opinion.

The belief that this invasion was long antecedent to that which later gave rise to the present fauna of the Pacific slope, is based upon the fact that the structural peculiarities of the group are of a more primitive type than belongs to the later invaders and that its present universal range through the Carribean region indicates that it was "an older faunal element" and was in position to take advantage of certain earlier continental extensions, which ceased to exist before the period of the later immigration.

The second Asiatic invasion is supposed to have occurred in the early part of the Eocene period. Its members belong to a more specialized type of molluscan development, and hence presumably of later origin. Passing over the Behring bridge, it traveled south, leaving along its track the ancestors of the present west coast fauna. The presence of the Mesozoic sea at that time and later the mountains and arid regions of the central province, have hitherto effectually prevented any advance toward the east. The southern extension of this tribe has been essentially the same as its predecessor. From it has decended a very large part of the existing fauna of central and southern America and the West Indian Islands.

As has already been intimated, the continental elevations which united the Greater Antilles with Central America undoubtedly afforded a land bridge between Cuba and the then islands of Florida, which gave the handful of the tropical species now found there an opportunity to pass into that region and spread as far north as climatic conditions would allow. That this invasion was comparatively recent, is shown by the small amount of differentiation which has taken place between the Floridan and Cuban forms.

The helicoid fauna of the eastern part of the continent is composed of two elements, both comparatively simple in organization and undoubtedly of great antiquity.

The one, comprising the patuloid snails, is probably nearest to the primitive type of all existing forms. It is, as might be expected, of almost universal distribution in all parts of the world, and on this continent, while its representatives are found in all the provinces, occupies the central region to the exclusion of the forms so abundantly developed both in the east and along the Pacific.

The other, the *Polygyrœ*, is wholly confined to America and is believed to be one of the few remaining races of the earlist forms of helicoid life. Although the palæontological history of the group is very scant, there cannot be much doubt that its ancestors have occupied eastern American soil ever since it had a fauna of *Helicidœ*. The same barriers which operated to prevent the eastern extension of the successive invasions of the Pacific coast from the old world, in all probability have been the means of preserving these native races from what might have proved a fatal competition with the more highly organized invaders from the west.

Of the source and method of distribution of the pulmonate fresh water mollusca little can be said. There has not been so much splitting up into families and genera as has occurred on the terrestrial forms. The genera as they exist today are substantially the same as they were when the race first appeared on the geological horizon, and this fact of great antiquity is borne out by their worldwide and almost universal distribution at the present time.

There is, however, a single genus of this class, whose peculiar distribution in recent times is one of the yet unsolved puzzles to the zoögeographer. This is a little group of limpet-shaped snails known as *Gundlachia*, originally discovered by the German naturalist, Gundlach, in Cuba and named after him. Subsequent discoveries have shown that it ranges north into the United States from Long Island to California and south into South America. It is not found in any other part of the world, except southern Australia, Tasmania and New Zealand. That it spread into North America from the south is shown both by its present distribution into that direction, and its absolute failure to appear either in former ages or at the present time in the fauna of Asia and Europe. It is possibly one of the few survivors of that mighty army of tropical forms which poured into North America in early Tertiary time from the southern continent and which later perished so miserably upon the advent of the glacial period. Its concurrent existence in South America and Australia is very interesting and is one of the many evidences both in fauna and flora which go to support the theory of the Antarctic continent in Tertiary times. "A strip of land with a mild climate extending across the pole from Tasmania to Terra del Fuego would have afforded a possible route * * * and the theory of a Mesozoic or older Tertiary migration to or from Australia * * * would explain its present position." Whatever may be the fate of the theory, the instance is an interesting one, as exhibiting the methods by which modern science from all possible sources—geological, palæontological and biological—seeks to reach the truth and reconstruct the history of the world.

All of the existing families of fresh water, gill-bearing mollusca date back to the era of the great inland lakes, which resulted from the separation of the Mesozoic sea from the adjacent oceans by the general continental elevation, which then took place. Not only every family, but "almost every, if not every, genus and many of the subordinate divisions of those genera, that are now among the living North American fresh water mollusca, have been recognized among the species that constitute the different faunæ, the fossil remains of which have been collected from the Mesozoic and Cenozoic strata of western North America."

The present distribution of the two great families of *Viviparidæ* and *Pleuroceridæ* which now constitute a most important feature of our fauna, is in some respects quite dissimilar, and, while our present knowledge of the distribution of these families and their progenitors in time, is not sufficient to enable us to speak of with the same certainty that may be done in regard to other groups, the facts, as they exist, give rise to the same interesting speculations.

The *Viviparidæ* are a family of almost universal distribution in the northern hemisphere and of ancient lineage, dating back to Jurassic times in both the old and new world. It is very abundantly distributed through the eastern United States, but curiously enough, it is lacking absolutely in the region west of the mountains along the Pacific coast. Nor does it extend into South America.

The *Pleuroceridæ* on the other hand, while dating back at least, as far as the Laramie period is purely a native American family and ranges from the Atlantic to the Pacific and as far south as Central America. Its affinities are very close to the old world family of the *Melaniidæ*, which, however, is also found in South America, but does not range further north than Mexico. It is a fact of great significance and one which may point to the origin of the North American family that representatives of both families are found associated in the fresh water deposits of the Laramie epoch. The local conditions which resulted in the extinction of the *Melanidæ*, but which permitted the survival of the *Pleuroceridæ* can only be surmised.

The occurrence of the *Pleuroceridæ* on the Pacific coast, where the *Viviparidæ* are not found, is also an interesting and important circumstance. As is also the further fact that the Californian species have certain peculiarities, which separate them from the eastern forms.

While there is not at present sufficient evidence perhaps to warrant it, a pleasing theory can be formulated, which accounts for the apparently anomalous distribution of these families. Assuming that the *Pleuroceridæ* are an offshoot from the old world *Melaniidæ* it would be easy to account for their introduction into North America as a part of the molluscan immigration in secondary times already alluded to in connection with the land mollusks. Passing south along the Pacific coast, entrance to Central and South America would be had and the subsequent eruption of South American forms into the north of Eocene times, would give an explanation of their appearance in the Laramie fauna. This would also give a rational explanation for the present existence of the Californian colony.

On the other hand if such were the history of the introduction of the *Viviparidæ*, it is difficult to see why it is not shown by a similar distribution to the west and south. In the same way, if the Californian *Pleuroceridæ* are derived from the former inhabitants of the Laramie Sea it is difficult to understand why, when we find the two families there associated under similar and evidently favorable circumstances, that the Sierra Nevada mountains should have proved an insurmountable barrier to the one and not to the other. The failure of the *Unionidæ* of the same fauna to effect an entrance into California is also significant.

But if we would assume that instead of coming from the orient, the *Viviparidæ* originated in North America, where from the earliest times there has been the greatest generic differentiation, and that like the *Camelidæ* among the mammals, they passed around the mountains to the north and spread westward over the Behring bridge into the old world, all such apparent inconsistencies would be obviated and theoretical conclusions would be in entire harmony with the known distribution.

The present unione fauna of North America far exceeds that of any other country in the abundance of its species and the almost infinite diversity of shape, size and ornamentation. The questions connected with the origin, differentiation and distribution of this family are therefore of peculiar interest to the American student. Like the other families of non-marine mollusca the ultimate origin or, rather, point of separation of these forms from the marine type, is unknown and even upon theoretical conclusions naturalists are not agreed as to the probable line of descent. "Although certain shells found in the Carboniferous and Devonian strata of Europe and America have been referred to the *Unionidæ* by different authors, the accuracy of such reference has been seriously questioned and American palæontologists have not generally recognized as belonging to that family any shells found in the strata earlier than Mesozoic time. "Beginning with the Jurassic period, however, undoubted *Unionidæ* are found and toward the end of the Cretaceous age a large and greatly differentiated fauna is found in both the new and old world." "As a rule the types that have hitherto been discovered in the Mesozoic and Cenozoic strata of the western part of North America, are such as now exist in different parts of the continent, especially its eastern half. This similarity of type, although it is somewhat more apparent in the later than in the earlier formations extends as far back as the Mesozoic epochs * * * and even in the case of a majority of exceptions to this rule, the relationship to existing forms is readily recognized. In short the almost exact identity of types of the fossil and living species is such as to leave no doubt that the former represent the latter ancestrally. The fact also that the types of these Mollusks had become so differentiated before the close of Mesozoic time, and that they have changed so little since, points back to a previous evolutionary history, which doubtlessly began in Palæozoic time."

The separation of Mesozoic sea from the open ocean and its gradual change of its waters from salt to fresh, was undoubtedly the cause of the great diversity of type, which so early developed itself in this family during that epoch, and which has, in this country, been perpetuated to the present time. "It is well known that the maximum of differentiation of mulluscan types takes place in marine waters, that it is much less in brackish waters, and that the minimum in this respect is reached in purely fresh waters." "We should, therefore, naturally expect to find in those strata which bear evidence of having been deposited in purely fresh waters a fauna meagre both in species and development, while in those strata that have evidence of having been deposited in waters which were a little salt, the *Unionidæ* would be much more differentiated." "This is exactly what is found to be the case, and indeed it is only in the last mentioned strata alone, that those species of Unio have been found, that possess the peculiar North American characteristics." "Judging from these facts, it would seem that these ancient *Unionidæ* were not only capable of living in waters that were a little salt, but that the influence of the salt upon them was such as is in a general way exerted by it upon all molluscan life producing a greater differentiation than would have been produced in fresh lacustrine waters, and such as has generally been supposed to have exerted upon the family in existing fluviatile waters. While it is not unreasonable to assume, that much of the differentation that now prevails in the living North American *Unionidæ* took place in fresh waters, the facts brought out by the study of the fossil forms seem to indicate plainly, that the characteristics which we call "North American" have been directly inherited from these fossil species, and the possibility also, that the later species received in Mesozoic and Tertiary times, their differentation under the influences of other conditions, among which was the diffusion of a small portion of salt in the waters in which they lived."

"If it be assumed, therefore, as is believed to be the case that the conditions of unione life have been preserved unbroken notwithstanding the physical changes that have taken place during the Mesozoic and Tertiary periods, it was doubtless accomplished through streams that are now western tributaries of the great Mississippi river system and which were then outlets of those great lakes in the deposits of which the fossil *Unionidæ* are now found." By this means an entrance was afforded into the waters of the Mississippi valley and an escape from the extinction which overtook their ancestors upon the final dessication of the Laramie sea. That this invasion into the Mississippi valley took place at a very early date is shown by the fact that the immigrants had time under their changed environment to develop into the species as they now exist before the advent of the glacial epoch. The extension of these forms through the eastern portion of the continent, both in preglacial and recent times, has been limited only by the physical barriers caused by the great water-sheds lying between the Mississippi, St. Lawrence and Atlantic drainage systems and unfavorable climatic conditions toward the far north and south.

Of their preglacial range to the north nothing is now known. But their hardy nature and ability to extend into new territory is shown by the fact, that during the temporary recedence of the great glacier, certain species found their way north through the then existing southern outlet of Lake Michigan into the St. Lawrence valley as far east, at least, as Toronto and were subsequently extinguished by the return of glacier. Upon the final disappearance of the glacier, but before the present drainage of the St. Lawrence system to the east had been established, a second immigration took place whose descendants, all possible retreat to the south having been cut off, now people the lakes and rivers of the states bordering on the great lakes. To the east, the Appalachian mountains had proved an almost total barrier at all times to any general extension in that direction.

The relations, if any, which the peculiar fauna now found in the states east of those mountains bear to the Mississippi valley, fauna have not yet been worked out. There is reason to believe, however, that it may be genetically connected through some early migration which spread around the southern end of the range and thence northward along the coast, and has been enabled to develop its characteristic form under peculiar conditions of isolation and local environment.

The peculiar and exclusive fauna of California has already been alluded to, but this characteristic is nowhere more strangely emphasized than in respect to its *Unionidæ*. There is absolutely no relation whatever with the eastern forms, and there is not the slightest evidence that a single one of the multitudinous unione inhabitants of the Laramine sea ever succeeded in passing over the mountains into the low lands of the coast. As has already been stated, the entire fauna of this region consists of a single European *Margaritina* and a few *Anodontæ*, which are so closely related to existing European forms that their specific distinction is very doubtful. And thus again, and most unmistakably, is the theory of the foreign origin of the fauna of the Pacific coast substantiated by the undeniable facts of the present characteristics and distribution of its molluscan inhabitants.

The present range of the European *Margaritina* above mentioned is one of the most interesting facts brought to light by the study of the recent distribution of our molluscan fauna.

It is common both upon the Atlantic and Pacific coasts, but is wholly wanting in the Mississippi valley and the interior region lying to the north. That it must have been an early immigrant from the old world is shown the fact, that to have allowed its present range it must have at one time extended clear across the northern portion of the continent. Its total disappearance in the interior region is in all probability to be attributed in common with so many of our faunal peculiarities to the effect of the glacial period. Upon the approach of the ice, there was undoubtedly a retreat, as far as possible, before it of all forms of animal life toward the south. By what means the eastern *Margaritinæ* were enabled to escape from the total destruction which overwhelmed their brethren in the interior cannot be told. But there must have been some factors connected either with the advance of the glacier or the means of retreat, which saved the eastern contingent from extermination and by which upon the subsequent recedence of the ice cap, the survivors were able to regain their former foothold in the northern Atlantic states, although prevented by physical changes from spreading again toward the west into the interior region.

The relations existing between the peculiar, so called "North American" types of *Unionidæ* and both the Tertiary fauna of southeastern Europe and the fossil and living fauna of Asia are very interesting and when fully known seem likely to give important data as to the origin of this widely extended family and the manner in which it has attained its present world-wide distribution. But the existing material is as yet too scanty to be used, even for speculative purposes.

Of the many interesting details of the local distribution of existing species, both in this and other families represented in our fauna, the already too greatly extended limits of this paper forbid mention.

From the roughly drawn outlines which have been given of the principal theories now advanced to account for the distribution of our existing fauna and of the main facts upon which they are based, some idea can perhaps be obtained from the nature of the work, which modern science seeks to accomplish, of the measure of success that has already been attained and of the possibilities, which lie before the student, of the geological and geographical distribution of the mollusca. The enormous advance that has been made within the few years that have elapsed since Darwin and Wallace opened the doors to untrammeled thought and investigation, it is but a foretaste of that, which surely is to come. And while perhaps it is too much to expect that, from the scattered debris of the wreckage of past ages, the chain of animal life can ever be reconstructed in its entirety, there is every reason to believe that, in the years to come, much that is now inexplicable will be made plain and that in its broad outlines, at least, and to a high degree of certainty the true history of its origin and development will be elucidated.

# THE SUB-CARBONIFEROUS LIMESTONE EXPOSURE AT GRAND RAPIDS, MICH.

BY CHARLES A. WHITTEMORE, GRAND RAPIDS.

(Read before the Academy, Dec. 26, 1895.)

My work as a member of the Kent Scientific Institute of Grand Rapids has called for many excursions to our limestone quarries and I now offer you a few notes from observations taken in the field and from what I could gather from those whose interest or business led them to a knowledge of the subject. Before entering upon the work I trust you will allow me to say a few words about the society I have the honor to represent. The Kent Scientific Institute was organized in January, 1868, and was shortly after incorporated under the laws of the state "for the study of the natural sciences and to maintain a natural history museum."

It succeeded a society known as "The Grand Rapids Lyceum of Natural History."

Museum material rapidly flowed into the society both by donation and purchase and in a short time there was a valuable collection on hand.

The society was organized as an independent body, but an agreement was soon entered upon with the board of education of the city whereby the board furnished a place for the meetings, and room for the collections. In return the society allows the board to use the museum material for instruction in natural history in the public schools. Therefore any teacher in the city can send for what he may wish to illustrate his science work. We have a collection of 700 mounted birds, 1,150 skins, 1,400 eggs, and nearly 10,000 species (30,000 specimens) of shells. There are 165 bottles of alcoholic specimens, more than 6,000 minerals and fossils, and 1,500 plants. Like most societies of this kind we are sadly in need of means to properly display our collection. In the 28 years of its existence the society has supported its meetings twice a month, and has kept alive a spark of interest in natural history. The museum has given pleasure and instruction to hundreds of scholars, and many a young man can date from it his inspiration to a life of natural science.

Although the general course of Grand river is to the west, opposite the city it flows to the south. Just below the city it begins a large bend to the west. In the river bed the rock comes nearly to the surface of the water and in some places it is below low water level. Consequently there is considerable current, whence our city gets its name, from the grand rapids of Grand river. On each side of the river there are hills, making a valley one and one-half miles wide. The highest point on the east side, our city engineer who gives me these figures tells me, is 165 feet high; on the west side of the river near the John Ball park, the hill is 148 feet above low water mark, hence another name, The "Valley City" of the Wolverine State. But we are not responsible for the latter part of the title.

The rock makes its appearance in the river bed at a point about 100 feet above Pearl street bridge. That it is limestone needs no argument, as it answers the acid test, has been burned for lime, and is identified by means of fossils which will be mentioned later.

On the the east side of the river the same rock was found in the excavations for Sweet's Hotel, but it had many holes through it. The same feature was seen in digging for the foundations for the National City Bank building. At Mr. Power's well, in the Arcade, just north of Pear street, the lime rock was found 14 feet thick under 6 or 8 feet of drift. These features indicate the southern edge of the formation, as shown on the map. In the west side canal bedrock was struck at a little more than 100 feet south of the dam. Away from the river the limerock was not found south of Bridge street, its boundaries, however, I do not know. The ridge is found in the river bed at a point near the Kent Furniture Co's shops, and slopes rapidly to the north. The apparent dip, as seen in the river bed, is to the south, but the true dip is N. E. by E.* Such must evidently be the case in order that the strata may pass under the coal measures of the center of the State. The upper line on the west side runs a little north of west, but has not been determined.

To Hon. Wm. T. Powers I am indebted for much valuable information concerning this outcrop.

The thickness of the rock at the head of the rapids is 52 feet. It is found under a drift deposit of two or three feet and in some places is covered only by the sod. The same kind of limestone, with the same crystals, is found at Kellogsville, six miles south of the city.

The strata have been extensively worked for building stone, both in the river bed and on shore. The rock is very shaly so that it cannot be used for much more than foundation walls. The openings are indicated by the spots on the map. Large piles have been frequently stored up for market, so that many opportunities for examination were given, both in the stone heaps and in the workings. The evidence that our limestone is sub-carboniferous, Prof. Strong tells me is abundant and satisfactory, both on the organic and stratigraphical sides. Evidence is given by the borings for salt wells, by seeing actual contact with the lower numbers of the carboniferous measures on the east, and contact with the Marshall sandstone—generally regarded as equivalent to the Waverly group, on the west. Additional evidence is given from the fossil remains, of which Prof. Strong published a preliminary list, as K. S. I. Miscellaneous Collections No. 3. He describes *Helodus crenulatus*, *Cladodus irregularis*, scales of *Ctenacanthus*, four species of *Nautilus* three of *Allorisma*, and several others too imperfect to be determined. *Lithostrotion canadense*, *Productus sanctatus*, and some specimens of *Hemiphronites* are also relied on for further evidence. Dr. DeCamp has found trilobites which he identified as "*Phacops bufo*." He sent them to Prof. A. Winchell for further examination. He has also found tesselated teeth in the Taylor street quarry and bony plates for such teeth. Of corals I have found *Cyathophyllum divaricatum* and *C. flexuosus*. Many other corals are found in the drift, but need not be mentioned here. The division of the sub-carboniferous is a more difficult matter. The *Lithostrotion*, Prof. Winchell writes indicates the St. Louis group of the Mississippi valley. The strata, are slightly undulating and in one opening there are several layers of the red limestone which will burn to hydraulic lime.

*50 to 60 ft. to the mile.

Although our lime rock is the same formation there is a marked difference in the crystals from the different openings. The Davis street quarry was worked to a depth of 28 feet below the sidewalk. Dog-tooth spar crystals were found abundantly and increased both in size and numbers nearly to the depth of the excavation. They were found in cavities in what are called "Geode Beds." In the deeper part of the pit the supply of crystals suddenly stopped. These crystals (specimens shown) came from that opening. I have at home two pieces of limestone, each about 14 inches long and 6 inches wide, one with crystals as large as this one, and the other with six or eight crystals of half this size, both imbedded in a surface of pyrite crystals. These crystals may not be large for other places but they are the largest we have found.

Iron pyrites crystals were found common at Davis street but seldom larger than $\frac{3}{8}$ cubes. The variety Marcasite was found in much greater quantity. I found one piece in the shape of a ball $1\frac{3}{4}$ inches in diameter. A piece of stone 4 feet long and $2\frac{1}{2}$ wide was found covered with pyrite cubes. I could have had it but it was too large for me. It is now doing duty in a cemetery. Deposits of calcite or brown spar were found here in larger pieces than in any other place. One piece was nearly a cubic foot contents. It is usually found as a nodule imbedded in the solid rock. Sometimes it is found in flakes which make up a vein through the stone. In this quarry also I found these curious double-colored crystals not found elsewhere. (Specimens exhibited.)

In the lowest heading of this pit, 28 feet deep, I found several cavities with the inside pitted instead of covered with crystals. I took out a few of the holes (?) which are represented by this sample. At the Davis street extension scalenohedrons were found in plenty, and here I found a cavity with loose crystals—the only one discovered. The crystals were imbedded in sand or clay, and had evidently fallen from the roof of the opening. There was so much outside earth in the cavity that it was useless to consider any of it as a residue of crystallization. In the opening just below the dam nodules of calcite were found, but nothing worth taking home.

In the excavation for the filter in the bed of the river just above the city water works, brown cubical crystals were found in good numbers. Here I found cavities containing gypsum—lime sulphate instead of the carbonate. Some of them, cavities as large as my fist, had the surface of the gypsum level. The holes were about two-thirds full, and the level surface indicated a deposit from solution.

In stone near the upper end of the exposure I found a few cavities lined with pyrites. These are rare and I have seen only one other, which was spoiled in taking out.

Many valuable specimens were found at the Taylor street quarry, but that was abandoned and filled before I came to the city, so I can only repeat what I hear from others. I have broken more specimens in the quarry than I ever took home with me, on account of the shaly nature of the stone. However carefully I might line out my work the piece would often break at right angles to my marks and the disturbance of my temper.

At the Myrtle street opening white and brown cubical crystals were found. The white crystals were rare and were not found in other places. Much iron pyrites was found here but in a decomposed condition. Joints and seams could be studied in this opening better than elsewhere. The principal joints were vertical and about four feet apart. The faces were as smooth as if dressed by hand. Their direction was to the northwest, evidently at right angles to the dip of the strata. Between the principal seams were smaller and irregular joints. The upper layers were here much disintegrated, and gave a good chance to study transition from rock to soil. There is no drift here—nothing but a thin sod—and we are evidently on the highest part of the limestone. The first 10 or 12 inches could be moved with a shovel; a pick-axe could take 10 or 12 inches more. Many pieces are found here yellow on the outside and with the grey unchanged stone in the center. I thought at first that the change was due to carbonic acid ($C O^2$) but Prof. Carmen applied a test and showed that iron was present. On the west bank of the river three openings have been made, to a depth of about 6 feet. A few brown cubical crystals were found in a limited area.

The best years for crystals were 1888 and '89. Those were phenomenal years and I was so situated that I could make frequent collecting trips, and succeeded in getting an unusually good assortment, both in varieties and number of specimens. I made an effort to be on good terms with the workmen in the quarries, and they were always ready to save specimens and to assist me. The display of crystals in the years mentioned attracted much public attention. On a pleasant morning it was a common thing to see 30 persons looking for specimens. Most of them were attracted by the bright yellow pyrites, and it was an easy matter for me to get from them what I saw were good specimens.

## NOTES ON THE SEISMIC DISTURBANCES IN MISSOURI, OCTOBER, 31, 1895.

BY JOHN M. MILLAR, ESCANABA.

(Read before the Academy, Dec. 26, 1895.)

Ex-Governor H. C. Brockmeyer, in a report of the earthquake of October 31, 1895, states that the site of the disturbance in Missouri is almost identical with that of the years 1811-12; that at Charleston the earth was cracked and volumes of water and sand poured through these fissures.

Sir Charles Lyell, in his Principles of Geology, devotes several pages to the earthquake at New Madrid, Mo. in 1811-12, and refers to the eminent Von Humboldt as follows:

"It has been remarked by Humboldt in his Cosmos that the earthquake in New Madrid presents one of the few examples on record of the incessant shaking of the ground for several successive months, far from any volcano," and then proceeds to say "that the inhabitants relate that the earth rose in great undulations, and when these reached a certain fearful height, the soil burst and vast volumes of water, sand and pit coal were discharged as high as the tops of trees. Flint saw hundreds of these deep chasms running in an alluvial soil several years afterwards."

In 1841, Lyell visited the disturbed region of the Mississippi which was said to extend along the course of the White River and its tributaries, to a distance of between seventy and eighty miles north and south, and thirty miles east and west, and saw on its borders many full grown trees still standing leafless, the bottoms of their trunks several feet under water, and a still greater number lying prostrate. And, even on dry ground along the margin of the submerged area he observed that all the trees of prior date to 1811 were dead and leafless.

He also made a careful examination of many of the cavities and rents, some of them still several feet wide, and a yard or two in depth, finding abundance of sand which some of the inhabitants, still living, had seen spouting from these deep holes.

It would appear from the foregoing, that these seismic disturbances are not new to the district; and it would be interesting to have a report of the recent disturbances to compare with those of nearly three-fourths of a century ago, that attracted the attention of such scientists as Baron Von Humboldt and Sir Charles Lyell.

## MICHIGAN BIRDS THAT NEST IN OPEN MEADOWS.

BY L. WHITNEY WATKINS, MANCHESTER.

(Read before the Academy, Dec. 26, 1895.)

All have noticed that the places chosen by different species of wild birds for their nests are not the same. Their homes vary in location and style of architecture as much as do the characteristics of the birds themselves.

Some species choose the dark, unfrequented forest for their home, others the open field in the full glare of the sun; some the barren cliffs of huge mountains, while others build floating rafts of mud and weeds in the marshy ponds. Again others are content to tenant perhaps the corner of a tumble down rail fence or nest in hollow trees or barns. Some nest high up in the branches of trees while others, equally shy, choose to rear their broods in bushes or upon the ground.

As the great, orchard-like trees of the oak openings were girdled and destroyed and great tracts of the heavy timbered land cleared, the lower peninsula of Michigan became more and more similar in physical aspect to the vast grass-land prairies of the southwest. Coincident with this greatly altered environment, and continuing to the present time, was inaugurated an unsettled, unbalanced condition in our avi-fauna resulting in a great change in the relative preponderance of species.

Those inhabiting the woodlands were crowded in a short time from great areas, while species which had heretofore been fortunate in the finding of even small tracts of open land to suit their tastes, were turned loose over thousands of acres of improved land within the period of a few years.

The Pileated Woodpecker was pushed north to the Canadian border, disgusted with so called civilization. The Wood Duck found her old stub nesting sites tipped over and burned; the Wild Turkey her briar patches and brush pile homes destroyed. The Passenger Pigeon, while enjoying the grain fields and fattening thereon in place of the wild acorns and nuts, was exposed to the destructive devices of those who soon learned that fat pigeons in the markets of the east were in demand at a good price, and they were rendered practically extinct in a short time. The Ruffed Grouse is now confined within fenced wood lots and is often found to wander into great cities and upon our lawns in absolute bewilderment.

Human beings have pushed their way into nearly every nook and corner of this continent and with them have been taken all the revolutionizing influences of civilization. Changes have been and are now taking place before our very eyes, in all the forms of life, as profound as any already chronicled in the great epochs of geological history. Certainly this is the age of man's absolute supremacy among the living things. He has destroyed whole species of birds and mammals and driven others to the verge of extinction; he has conquered the forests and wrought havoc with the wild flowers.

To make more plain and limit the scope of this treatise, which, of necessity must be longer than I hoped, I will include in my list only such species as I have found nesting upon the ground or in the open fields and meadows, excluding those found nesting upon the boundary fences or in the border shrubbery and brush piles or in lone trees in the open ground; also those nesting in the open marsh lands which are undrained and boggy to the extent of being unfit for hay or pasture.

As a further aid in clearness, I will separate meadows into two classes, namely, the typical upland hayfield or pasture and the so called "marsh" meadow which is drained and pastured or grown to its native grasses and sedges for hay.

We will first consider the upland nesters:

The American Bittern, *Botaurus lentiginosus*, is included among the nesters of the upland fields from one instance only, which came under my personal observation. I have never heard of a like case in connection with this species and it was to me a very interesting one.

On June 27 1892, I received a letter from a friend in Bridgewater, Washtenaw county, telling that "a bittern had its nest in his clover field" and if I wanted the eggs to come at once. As the location was a peculiar one I lost no time and arrived to find the nest undisturbed in a small bunch of standing hay which had been skipped in mowing on its account. This nest was a mere platform, upon the ground, of the surrounding clover stems bent down with some plucked and carried to the spot. The American Bittern almost invariably builds its nest either very near the border of sloughs and lakes, composed of rushes and flags made into a rude platform raised slightly above the water in the bogs and reeds, or situated in the wet marsh lands, made up of grasses and sedges. Of the many nests which I have observed, all were so situated save in this one instance. In the spring of 1892, the marshes were flooded from continuous rains until the bogs and wet flats became sheets of open water, entirely uninhabitable by birds which usually nested therein, and this fact I will venture as a possible reason for this nest being located in the clover field upon a hill, within twenty rods of a farm house and nearly one-half mile from any water. The four or five eggs are slate color or mud color. The food of this species consists of frogs, fishes, pollywogs and grasshoppers. Arriving before or by the middle of April, it at once begins its odd and unaccountable notes which give it the name of Thunder Pumper and Stake Driver. The American Bittern is probably of little economical importance and does no harm, serving to add to the picturesqueness of the water landscape as it wings its way in measured flaps over the placid waters, or stands motionless with beak pointing straight upwards, in the bog.

The Bartramian Sandpiper or Field Plover, *Bartramia longicauda*. is a very interesting bird. Unique in its class as caring little or nothing for the proximity of water, this long-legged bird of the uplands is little noticed or generally known, on account of its stealthy measured movements. It arrives with us usually in the last week in March and builds its nest in a rather open spot such as the border of a gravelly knoll, with scarcely any material to protect the eggs. Like the Killdeer it sometimes makes its nest close to the hills of growing corn upon the mellow soil. The eggs are four in number of a brown or clay color, variously spotted with darker shades and black. The food of the Upland Plover consists of both seeds and insects. In the early part of the summer, it consists about equally of each; in haying time, more largely of grasshoppers, crickets, et cetera; and later on when the grain is harvested, the stubble fields are sought and the birds fatten upon the grain left on the ground. As this bird stands motionless, as is its habit, it is not easily detected owing to its close mimicry of the natural surroundings and the passerby is not aware of its presence until two sharp, quick whistles, exactly as a man would whistle to his dog if near him, arrest his attention. This is the note of alarm and as the supposed person is sought on all sides, the graceful flight of the rather large bird betrays the mistake. It is of much benefit to the farmer and of no harm.

The Killdeer Plover, *Ægialitis vocifera*, is a very generally known species of which I need say but little. Coming to us from the south the last of February or first of March and usually remaining late in November or in some instances even all winter, it makes itself known at all times by its characteristic note, which is its name, as it runs before us upon the ground or flies round and round overhead. Nest is in thin grass lands, in corn fields or plowed ground, preferably within a short distance of water. Eggs, four, clay colored, with black and brownish spots especially about the larger end. Food mostly of insects, some seeds and grains. A very useful bird, and does no harm.

The Quail or Bob White, *Colinus virginianus*, is a bird equally well known to the tiller of the soil, the sportsman and the fastidious epicure of the city café. It is said not to be a migrant because it is a winter resident wherever it is found. When the Quail betakes itself to the tamarack swamp or to the farmyard for food and for protection from the cold storms that sweep the hills where it has passed the summer, it is perhaps as truly migrating as are the species which regularly recede southward on the same account. We see this same gathering together, in protected spots or where food is abundant, of many other of our winter residents. Many species go south because of cold weather while others only go because their food becomes unobtainable as in the case of most of the ducks, and the Robin, Crow, etc. The Quail begins to whistle with the first warm days of spring not nesting however, until the latter part of May and usually not until June. Some nests have been found late in October or even in November, if I recall correctly reports at different times in our ornithological publications, these of course being second broods or the nests made after the first nests have been broken up. The mother remains with her brood usually until they are grown, and in the fall of the year the different coveys represent one or more entire broods, they not separating until they pair off the next April. The Quail is confined, I think, in Michigan, to the lower peninsula, although there are reports which would show that it has straggled farther north. It is not found, as near as I can determine, in any numbers much north of the southern boundary of Roscommon county, the influence of the great lakes upon the isothermal lines in this state probably influencing the boundary line of their habitat on the north. In the southern tiers of counties, the Quail usually nests in the hay fields, and now that the mowing machine and horse rake do nearly all the work, every nest so situated is destroyed. The farmer usually wishes to protect the Quails, but the nests, which are hidden in a tuft of clover or grass, with the blades neatly pulled together overhead, defy apprehension and when once frightened away by the machines, the sitters never return. This fact of so many nests being broken up coupled with the lack of protection from the rigor of winter as the thrifty agriculturist has each and every shrub and vine cut from the fence corners and along the roadside, means fully as much in its very noticeable diminution in numbers, as does the yearly onslaught of the hunters. Various gun clubs in the state have already made efforts at restocking the country with Quails by importations from Kansas and Nebraska. The eggs are usually from eighteen to twenty-five in number, pure white and top shaped. Its food consists of insects, grains and seeds in the summer and fall, and in winter almost entirely of wild seeds. In the crop of one which I examined, a remarkably large seed for the bird to swallow was sent for identification to Prof. Wheeler, our courteous consulting botanist, who reported it to be that of the Skunk Cabbage, Symplocarpus foetidus. Of little or no harm, as the grains eaten are almost wholly waste, and of great economical importance. Both confiding and beautiful, it deserves whatever encouragement and protection we may be able to give. A brood of Quails which I hatched and reared with a bantam hen, grew to be very tame and kept our vegetable garden entirely free from insects the summer through. (For full notes, see The Oologist, Vol. XI, No. 12 and Vol. XII, No. 1.)

The Mourning Dove, *Zenaida macroura*, I have found once and only once nesting upon the ground in an open field. A few bushes growing in a slight hollow had been cut and burned and the ground sown broadcast to timothy. One little branch lay unburned upon the ground with the grass growing up through it and about two feet from this, where the grass was short and sickly looking, was the nest, built flat upon the ground and composed of a few small twigs and grass stems. The bird was flushed and the two white eggs seen. I understand that in prairie regions this is a common habit of the Mourning Dove, but here where abundance of favorable nesting sites are at hand, it is certainly very curious that this bird should have chosen to spend her time in incubation and rear her brood where any and all the night marauders would be likely to molest her home, and when she had been brought up differently. Food consists of insects, grains, seeds, etc.

The Marsh Hawk, *Circus hudsonius*, is the most graceful, most beautiful hawk on wing, that is found in our state, and the only representative of the birds of prey, with the possible exception of the Short-eared Owl, found nesting in the open fields. Coming to us late in February or early in March and remaining very late in fall, this bird is almost constantly seen in favored localities, soaring low over the meadows, poising with flapping wings about to dart below upon some unsuspecting rodent, or dashing into our faces, as we come over a hill, as suddenly to vanish from view, and we are always thrilled by this fairy form in blue or brown (the colors of the male and female bird, respectively). Nests with eggs may be found from the first of May to the first of August. Perhaps the more usual site is the wet, bushy marsh or bog, where the nest is raised several inches above the wet moss and water, composed of various sized sticks for a foundation and reeds, grasses and sedges—a rather coarse structure and bulky as is usual with the nests of hawks. Nearly as often is the nest placed flat upon the ground in the hay-fields, or in the growing wheat, rye, oats and barley. In such places it is composed simply of a few spears of the grass or grain plucked and laid upon that which may be bent and trampled down upon the spot. With few exceptions these nests are destroyed before the young are ready to fly. I find many broken up each year. Eggs five, pale blue, usually unmarked. The food of the Marsh Hawk consists of mice, frogs, grasshoppers, crickets, etc., with very seldom a young bird which is learning to fly. It has never been seen, I think, to molest poultry, or birds which are able to fly. Of no harm whatever and of exceeding benefit to the farmer.

The Horned Lark, or if I am to be technically correct I suppose I must say the Prairie Horned Lark, *Otocoris alpestris praticola*, (although I always protest in my heart these varietal species which I could not distinguish with certainty one from another if I had them here before me) remains with us throughout the year and whether chasing each other about the snow-clad fields or running before the carriage in the dusty road, they are always the same sprightly cheery little fellows, showing scarcely any fear. The nests are usually placed in a slight depression by a tuft of grass and composed of grasses and rootlets, without any great care being manifest in the construction. The five eggs are of a drab color made up of innumerable spots of that tint so close together as to give a nearly solid effect. The nests of this species may be found from the first of March to the middle of April or perhaps a little later than that. I have found about the middle of March the usual time, and it is a common thing to find the sitter surrounded or nearly covered with snow. The food of this bird consists of both insects and seeds. Of no harm and of some use though I am not as yet certain to what extent insects are taken.

The Bobolink, *Dolichonyx oryzivorus*, arrives in Washtenaw county from the south usually between April 30 and May 5. This bird being one of the few species dressed in black and white that we can boast as summer residents, at once tells of its return in one of the most animated songs which the woods and fields can furnish. The nest is built during the latter half of May and is so concealed beneath the thick growth of clover, timothy, etc., as to practically preclude all chance of finding. It is composed simply of grasses upon the ground, and the five eggs, of a mottled, stony color, so resemble their surroundings as to make it very inconspicuous even when actually exposed to view. Early in the fall, the male Bobolink changes its garb of black and white to the usual and more sombre plumage, of brown tinged with yellow, of the female bird and proceeds southward to become the dreaded "Rice-bird" of the plantations, where it is killed by thousands and sent to the markets. The food consists of grains, seeds and insects. With us in the north it is of no harm and some importance. In the south a pest. One of our finest open meadow species.

The Cowbird, *Molothrus ater*, presents a subject in ornithology hard to treat by a person who loves birds as I do. He neither builds his nest nor feeds his family and as is usual with the biped loafer, we find the above traits accompanied by those of bold trespass and destruction of his neighbors belongings, at the same time requiring and expecting the latter to rear his family by their hard work. The eggs of the Cowbird, which are white or bluish-white, varyingly speckled with brown and black, are parasitically installed, apparently at the convenience of the layer, as occasion presents itself, within the nests of so many species that it would be out of the question to think of naming them here. Of the meadow nesters, which are included in the present list, the eggs of the Cowbird have been found in the nests of the Mourning Dove, Bobolink, Red-winged Blackbird, Meadowlark, Black-throated Bunting, Grass Finch, Song Sparrow, Grasshopper Sparrow and Prairie Horned Lark. The food of this bird consists of seeds and grain and some insects, especially ticks from the newly shorn sheep. A pernicious pest, setting a miserable example to man and beast.

The Grass Finch, *Poocaetes gramineus*, is a bird so well known the State over as the "Ground bird," that the mention of that term is at once understood in every household. In all homes the "ground-bird" is a well known and significant term to those who seem to think that all small birds of a brown color seen upon the ground in the fields belong to one species and that species is the "Ground bird." I have several times been hotly arraigned because I said that the terms "sparrow," "blackbird," "ground-bird," etc., were misleading and should never be carelessly used to designate a particular species; and even called a "bird crank" when I asked some ornithologists of this type to pick out a "ground-bird" from the skins in the sparrow drawers of my cabinet. I wish that every member of the Michigan Academy of Science would aid in introducing the correct and less confusing English names for birds, mammals, plants, etc., among the common people who may be interested enough to learn, for until this is done, the popular influence of the scientist, who has spent years in preparing himself to be of use to the masses, will be of little avail. The Grass Finch, Vesper Sparrow or Bay-winged Bunting, as it is variously and correctly called in different places, is one of the ground nesting species which has increased particularly in numbers, since the clearing up of the land and bids fair in time to outnumber in individuals any other species. Arriving usually in April, it is seen everywhere about the fields and along the roadside. The nest is situated in the grass upon the ground almost anywhere and is in such situations composed of grasses and stems with rootlets and occasionally horse hairs for a lining. Other nests are made in the cornfields next to the hills of grain and this seems to be a favorite location, where the materials used are mostly grass roots placed in a natural depression in the mellow soil. The outside rows are most used for their nests. In one corn row eighty rods long, I have found nine different nests on the same day, all with eggs. The nesting season extends through May, June and July. Eggs four or five, pale bluish-white, variously marked, splashed and mottled with lilac, chocolate and darker shades. There seems to be no limit to the variation of markings in eggs of the Grass Finch. Food mostly seeds —some insects. Of no harm and probably from its great numbers a very useful species.

The Lark Sparrow, *Chondestes grammacus*, I have found only once nesting here at Manchester, though the late dates on which they are occasionally seen, lead me to believe that they quite frequently do breed. On May 20, 1896, I took a set of five fresh eggs and fully identified the female bird which was taken to make positive the find. The nest was upon the ground, in an open field, in a slight depression at the foot of a bitter dock plant. It was composed of grasses and rootlets and very much resembled the usual nests of the Grass Finch. The female bird was so tame that she would return to sit upon the eggs, after being flushed, while I was standing within ten feet of the nest. The eggs of the Lark Sparrow are creamy white, penciled and splashed with markings of chocolate brown and delicate lilac especially about the larger end. They resemble very much those of the Orchard Oriole in size and color. The pencilings upon the eggs also remind one of the markings upon the eggs of the Red-wing. This is not a common bird, though each spring a few are noted. They arrive in April rather later than most of the sparrows and remain until into May with the last of the Juncos and White-crowned and White-throated Sparrows.

The Song Sparrow, *Melospiza fasciata*, is by far the most attractive sparrow that we have. One of the first birds to greet us in March, inhabiting any and all sorts of ground, whether dry or damp, bushy or open, especially seeking the proximity of the farm yard and garden, he pours forth the sweetest, purest praise of spring that comes from all the feathered chorus, and when all birds are gay. The nests, composed of grasses and usually lined with finer ones and hair, are situated in bushes, upon the ground, in tufts of grass, in brush piles and even inside of buildings; in fact in every conceivable place. The eggs are five, bluish-white with markings of reddish brown in endless variety. The food of the Song Sparrow is almost wholly of insects if they can be found and the seeds of grasses and weeds. A bird of no bad habits and of inestimable benefit.

The Grasshopper Sparrow, *Ammodramus savannarum passerinus*, is a common bird in the hay-fields and yet some very competent observers have never noted its presence owing to its rather shy ways and its general resemblance, when not specially noticed, to others of its class such as Field Sparrow, Grass Finch, etc., though it is smaller than either. However, if the peculiar, tremulous, balancing flight, very like that of the Spotted Sandpiper, is observed, and the rasping tones of the singer are heard, our attention should be seriously attracted to the odd little bird whose every move is characteristic. It is named Grasshopper Sparrow from the peculiar resemblance of its song to the stridulating note of the grasshopper. It is usually found singing from a windrow of hay, the top rail of a fence, or any prominent object not very high above the ground. This bird, which is increasing in abundance each year, arrives from the south about the first of May, and the first brood is grown before haying time comes, the second being very often destroyed when the grass is cut. The nest is situated upon the ground, close to a tuft of grass, where the general growth is rather thin, and if possible in some natural depression such as is made by a cow or horse stepping in the mud, or where a small stone has been turned over, etc. It is composed loosely of grasses, roots of grasses, and sometimes hairs, carelessly placed. The usual clutch of eggs is five, white, speckled and in some cases splashed slightly, with reddish brown. The food of the Grasshopper Sparrow, I am very positive consists largely of insects. The young, at least, are fed almost entirely with insects and I have often seen the parent birds carrying larvae about in their beaks for hours after the nests had been destroyed, looking for their brood. The adults feed also upon seeds to some extent. Of no harm and of great benefit.

The Black-throated Bunting, *Spiza americana*, is the latest species to follow the opening up of the country, bidding fair to become a common species where it has been heretofore very rare or wholly unknown. It is as yet abundant only in certain restricted localities but is becoming more generally distributed each year. It is with us at Fairview Farm already somewhat common, several pairs usually occupying each forty acre hay lot. The nests are, so far as I have observed, always situated upon the ground in the thick grass, or clover fields, or fastened among the growing stems a few inches from the ground. The four eggs are laid usually in early June and are almost exact counterparts in color and size of those of the Bluebird. They are, however, of a more round-oval form than those of the latter, one end being about as large as the other. In fact they come nearer being round than the eggs of any species that I can recall. Many nests, also, of this bird are destroyed in haying time. The food consists mostly of insects—some seeds. We should welcome this bird to a place among the common species in our State.

The Meadowlark, *Sturnella magna*, is one of the most universally known species in the entire list. Its unmistakable identity, bright appearance and attractive notes, cause it to be noticed particularly and remembered by all who meet it. The Meadowlark arrives in Michigan usually between March first and tenth and at once fills the air with its mellow, whistling song. The first nests are made early in May and nidification is continued through June. They are built upon the ground and are among the most elaborately formed, for protection, found in bird architecture. Built usually in the side of an especially thick tuft of grass in the meadow, the blades near at hand being drawn down and woven together over the nest proper, which consists almost entirely of dried grasses, we very often find in connection a tunnel of woven grass stems conveying the bird as she leaves the nest several yards unseen before she rises to fly. The eggs are five, crystal white, speckled and blotched with reddish brown. The food of the Meadowlark consists largely of insects, both of imagos, such as beetles, flies, bugs, etc., and the various lepidopterous, hymenopterous and dipterous larvae which infest our hay fields. Grasshoppers and crickets are also taken. When insect food cannot be obtained, as when an individual occasionally winters with us, seeds and grains are readily taken.

I have little doubt that the Field Sparrow, *Spizella pusilla*, and the Brown Thrasher, *Harporhynchus rufus*, occasionally nest upon the ground in the grassy borders of open fields. Their nesting sites vary much and they seek the brush heaps and shrubby borders of the open country rather than the deep woods. Indeed, I have been informed that they have nested upon the ground in the open, but as I have not personally known of such an instance I will not include them positively within this list of species.

In the mucky lowlands or marsh meadows, we find that of the above list of upland nesters all are found to be present except the Prairie Horned Lark, Grass Finch, Grasshopper Sparrow, Lark Sparrow, Mourning Dove and Dickcissel or Black-throated Bunting. With these exceptions we find the same list holding good but with the addition of three species not found nesting in the uplands. These we will briefly consider.

The Prairie Hen, *Tympanuchus americanus*, was found in great abundance by the first settlers of Michigan, inhabiting the marshes and patches of prairie land and among the more open hills upon which the scattered, wide-spreading oak trees grew. As the land was cleared, they continued to thrive and fatten in the grain stubbles, but when every man came to own a gun, and they became scattered in the fall over the whole upland country they were slaughtered without mercy. The heavy, bungling rise of the Prairie Chicken makes it so easy a mark that it can scarcely be missed and it was persecuted for fun until it was practically extinct except in the prairie regions of the southwest of the State where yet a few remained. On April 13, 1894, however, a flock of sixteen were all at once discovered near Norvell, Jackson county. (For full notes concerning this flock see *American Naturalist*, Vol. XXVIII, No. 355.) Since that time they have done very well until last fall when the hunters ruthlessly slaughtered eleven birds and this after I had distributed signs, warning hunters to keep off, among the owners of all the land where they were found. These signs were generally tacked up, but under the softening influence of a few cigars the land owners yielded to so called friends and the birds suffered. They have become very shy and are so scattered now that they are in reality very difficult to obtain so I hope for their presence for a few years yet, at least. The nests are made of grasses and leaves in the thick herbage of the drier marshes, early in May. One nest found last summer contained ten eggs of a brownish drab color. The food of the Prairie Hen consists of grasshoppers or locusts, crickets—in fact almost any insects, through the summer. They usually resort to the grain stubbles after harvest where the waste kernels are eaten until the bird becomes almost helplessly fat. Of no harm, to speak of, and undoubtedly of great service to the farmer in ridding the fields of noxious insects. Why will he not protect them? Is it stupidity or ignorance? Probably both.

The Red-winged Blackbird, *Agelaius phœniceus*, has in one instance been found to leave its customary reeds and cat-tails in the bog and build its nest in a tuft of grass in an open marsh, well drained and regularly cut for hay and afterwards pastured. It was situated at least one-fourth mile from water and entirely away from any bush or other protection. Usually coming to us about March 4th, we must admit that the red-wing, as it gathers in huge flocks in the trees near our homes, furnishes us with a sleigh-bell chorus of undeniable richness, interspersed with the "tweck," "tweck," of those stopping for breath. This is one of the few species which are gregarious in their song. The nests are usually built in reeds, boggy tufts of sedge, or among cat-tails, standing in the water, and composed of coarse grasses and the leaves and shreds torn from the surrounding flags. The four eggs are light blue, with a slaty tinge, splashed, spotted and penciled with black, brown and purple, especially about the larger end. The young are fed largely with insects, those species found about the water, which are of little if any harm to us, being most taken, while the adults feed almost entirely upon wild seeds and grains when they can be obtained and are frequently of great damage to the farmer. As is the case with every species possessed of grain eating tendencies, it is apparently of little damage until the young are fledged and all are gathered together preparatory to their migration south. The red-winged blackbird is of doubtful reputation, probably just about paying for its board. We will at present give him the generous benefit of the doubt.

Henslow's Sparrow, *Ammodramus henslowi*, is a rare species with us excepting in a few restricted localities. Its habits are little known from study in this State. It is an inhabitant of the marsh lands, preferably such as bear an open growth of short, shrubby plants, called locally with us "hard hack" (*Potentilla fruticosa*). Its flight and habits are much as in the case of the Grasshopper Sparrow, to which it is closely related, being, however, much more shy and less easily seen. I have taken in all, six specimens of Henslow's Sparrow, all at or near Fairview farm at Watkins Station, Mich. Three of them are now in my collection, one is at Lake Forest University, Illinois, one at the Indiana Academy of Science, in charge of Amos W. Butler of Brookville, that State, and the other taken to Ann Arbor by Mr. A. B. Covert, presumably in the collections of the University of Michigan. Mr. Covert took a specimen of this species at Pittsfield Junction, on the Ann Arbor & Lake Shore railways, I believe in the spring of 1894. The nest is not distinguishable from those of other sparrows, situated usually in a tuft of grass and composed of dry grasses. It was my good fortune to have the pleasure of recording the first nest of Henslow's Sparrow, reported from Michigan, (See *The Nidiologist*, Vol. 1, No. 12.) It was found late in May, and contained five eggs of a bluish-white, speckled with reddish-brown. Mr. Arnold, of Battle Creek, tells me that another nest of this species has been taken near Pine Lake, east of Lansing.

Of the species which might be included among the nesters of the open marshes, but which usually at least select the more wet or bushy ground are: Short-eared Owl, *Asio accipitrinus*, Maryland Yellowthroat, *Geothlypis trichas*, Swamp Sparrow, *Melospiza georgiana*, Long-billed Marsh Wren, *Cistothorus palustris*, Short-billed Marsh Wren, *Cistothorus stellaris*, King Rail, *Rallus elegans*, Mallard, *Anas boschas*, and Sandhill Crane, *Grus mexicana*.

In the list of meadow nesters of which I have spoken, we find of the various orders, as follows:

Herodiones (cranes, herons, bitterns, etc.), one.
Limicolæ (waders), two.
Gallinæ (scratchers—quail, grouse, etc.), two.
Columbæ (doves), one.
Raptores (birds of prey), one.
Passeres (perchers proper—sparrows, thrushes, etc.), eleven.
Total, eighteen species.

## PRELIMINARY NOTES ON TERATOLOGICAL FORMS OF TRILLIUM GRANDIFLORUM (MX.) SALISB.

BY CHARLES A. DAVIS, ALMA.

(Read before the Academy, Dec. 27, 1895.)

[Abstract.]

Teratological forms of this plant are very common in Michigan, although references to them in literature are mainly confined to short notes in various botanical journals. The most common change found is a striping of green in the otherwise white petals. This is usually accompanied by elongation of the petioles of the leaves, the peduncle of the flower, and a lessening of the amount of pollen in the anthers, and almost universally by a more or less complete atrophy of the pistil, which commonly contains no ovules, even where there is a very slight green line in the petals. Doubling of the parts, reversion of the stamens and pistils to green leaves, suppression of the foliage leaves, elongation of the petioles and peduncle so that they arise from the rootstock, occurrence of whorls of two or four leaves in all the parts of the plants, change of color in the sepals so that a double white flower was produced, change of color in the white petals to green, conversion of ovules to green leaf-like bodies, were noted. No definite conclusion as to the probable cause of these changes has been reached.

Abstract of a more complete paper by the author is to be found in proceedings of the A. A. A. S., Vol. XLVI, p. 271, 1897.

## A NEW SCIENCE,—THAT OF SANITATION.

BY HENRY B. BAKER.

(Presented to the Michigan Academy of Science, Dec. 27, 1895.)

This paper does not relate to any of the prominent sciences which go to make up sanitary science, such branches of knowledge, for instance, as bacteriology, and the germ theory of disease, now well established. It is limited to a branch not heretofore accepted as a science, but only as an art, the art of sanitation. In recent years what was formerly called hygiene, authors have called sanitary science. Some have adhered to the old term,—hygiene, but have claimed that it has come to be a science, including several branches, bacteriology, climatology, etc.

A quarter of a century ago hygiene was defined as "The art of preserving health."* Not long ago, in the opening lecture of the course on military hygiene, in the U. S. Army Medical School in Washington, D. C., Dr. Smart has said: "Hygiene is the science of health. It was called by Prof. Parkes the art of preserving health; but since he wrote the introduction to his classical work, hygiene has been developed, by study

*First sentence of the introduction to "A Manual of Practical Hygiene," etc., by Edmund A Parkes.

and observation, into a science; and its art, or the practical application of its laws, has received the name of sanitation."* Herbert Spencer has maintained that generally the arts have preceded the evolution of the sciences upon which those arts were afterwards securely based. This instance, mentioned by Dr. Smart, may, I think, be extended one step further; because, as I shall endeavor to show, what he has called the art of sanitation has now been developed "by study and observation, into a science"—the Science of Sanitation. A science is knowledge which has become accurate, and systematically organized or arranged so as to supply general rules or laws.

For the past twenty-five years a movement has been in progress in Michigan which, during the past few years, has been crystallizing into a Science of Sanitation. Sanitary arts have been practiced, and their results have been observed and recorded; these records have gradually become more accurate, they have been systematically arranged, so as to evolve general statements or rules which year by year have been found to be approximately uniform, until today it is possible by means of this science to predict, with reasonable accuracy, what will be the result of action or of non-action according to the arts of sanitation which have been adopted in this State. When knowledge has been so collected, recorded, and arranged, as to serve the purposes of prophecy, it is worthy of being styled a science. Let me now introduce the evidence that this has been done:

Here are a number of diagrams, constructed accurately, representing, according to fixed scales, the results of isolation and disinfection, and the results of neglect of these two measures, in two diseases. A study of these diagrams proves that, in two diseases (scarlet fever and diphtheria) there occur about five times as many cases and deaths in those localities where isolation and disinfection are not enforced as in those localities in which these measures are enforced. The points to which I wish here to ask attention are: (1) that—in a series of areas of about the same extent, such as the townships, villages and small cities in Michigan (the large cities being excluded), given the introduction of a case of diphtheria or of scarlet fever, if nothing is done to restrict it the disease tends to spread until, on the average, there have been about thirteen cases, and two or three deaths. This is one general rule or statement of fact. (2) Another general rule or statement of fact is that in a similar series of areas, given the introduction of a case of diphtheria or scarlet fever, if isolation and disinfection are enforced not thirteen cases and two or three deaths, but only about one-fifth of those numbers occur. A comparison of these two general facts, leads to a third general statement,—that about four-fifths of the cases and deaths from scarlet fever and diphtheria are prevented by isolation of first cases together with such disinfection as has been practiced in Michigan under the direction of the State Board of Health.

*The Journal of the American Medical Association, Dec. 21, 1895, p. 1070.

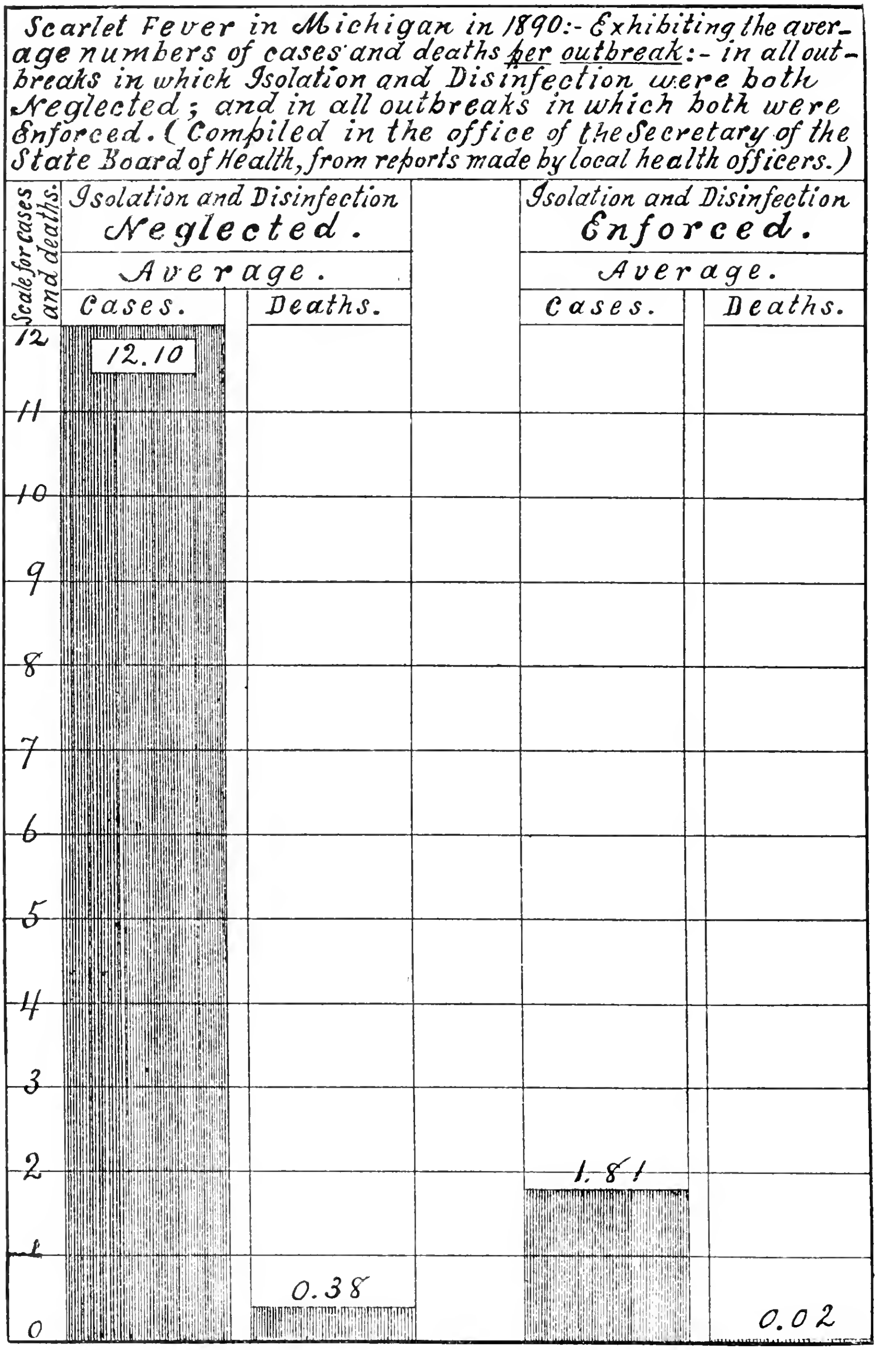
Scarlet Fever in Michigan in 1890:- Exhibiting the average numbers of cases and deaths per outbreak:- in all outbreaks in which Isolation and Disinfection were both Neglected; and in all outbreaks in which both were Enforced. (Compiled in the office of the Secretary of the State Board of Health, from reports made by local health officers.)
Scale for cases and deaths.
Isolation and Disinfection Neglected.
Average.
Cases.
Deaths.
Isolation and Disinfection Enforced.
Average.
Cases.
Deaths.
12
11
10
9
8
7
6
5
4
3
2
1
0
12.10
0.38
1.81
0.02

Plate 532.

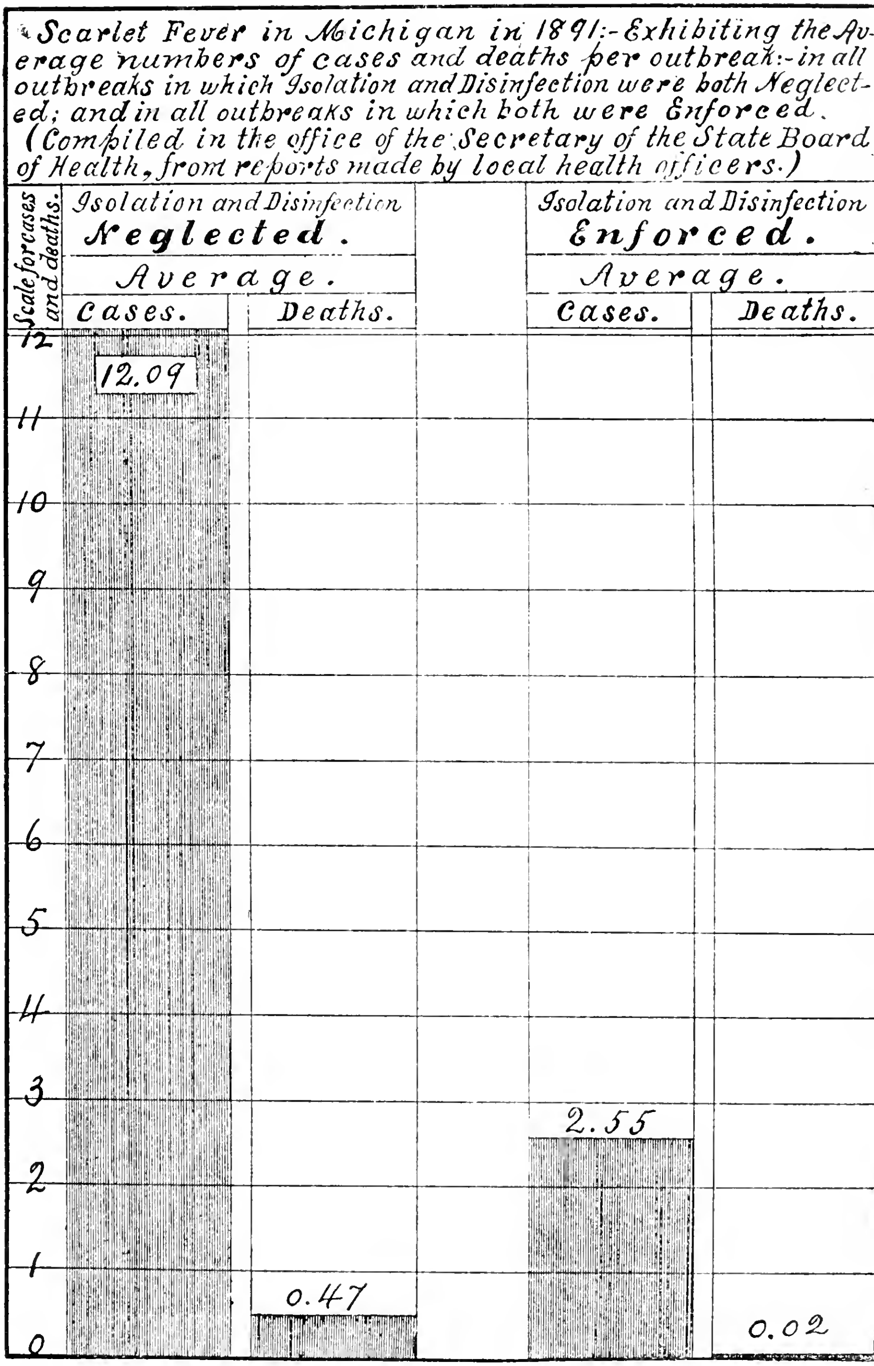
Scarlet Fever in Michigan in 1891:-Exhibiting the Average numbers of cases and deaths per outbreak:-in all outbreaks in which Isolation and Disinfection were both Neglected; and in all outbreaks in which both were Enforced.
(Compiled in the office of the Secretary of the State Board of Health, from reports made by local health officers.)
Scale for cases and deaths.
Isolation and Disinfection Neglected.
Average.
Cases.
Deaths.
Isolation and Disinfection Enforced.
Average.
Cases.
Deaths.
12
11
10
9
8
7
6
5
4
3
2
1
0
12.09
0.47
2.55
0.02

Plate 547.

ISOLATION AND DISINFECTION RESTRICTED DIPHTHERIA IN 1890.

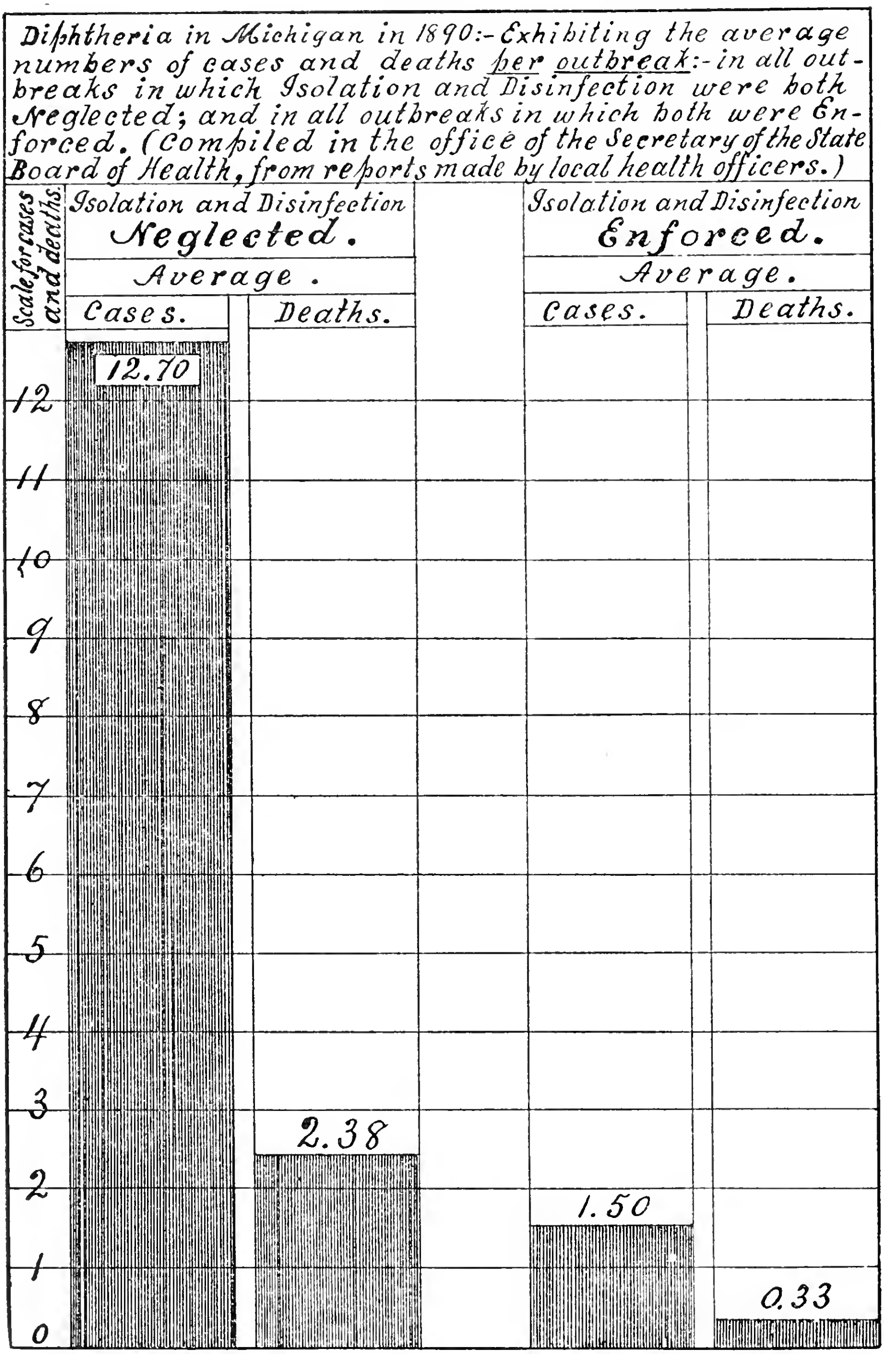


Plate 530.

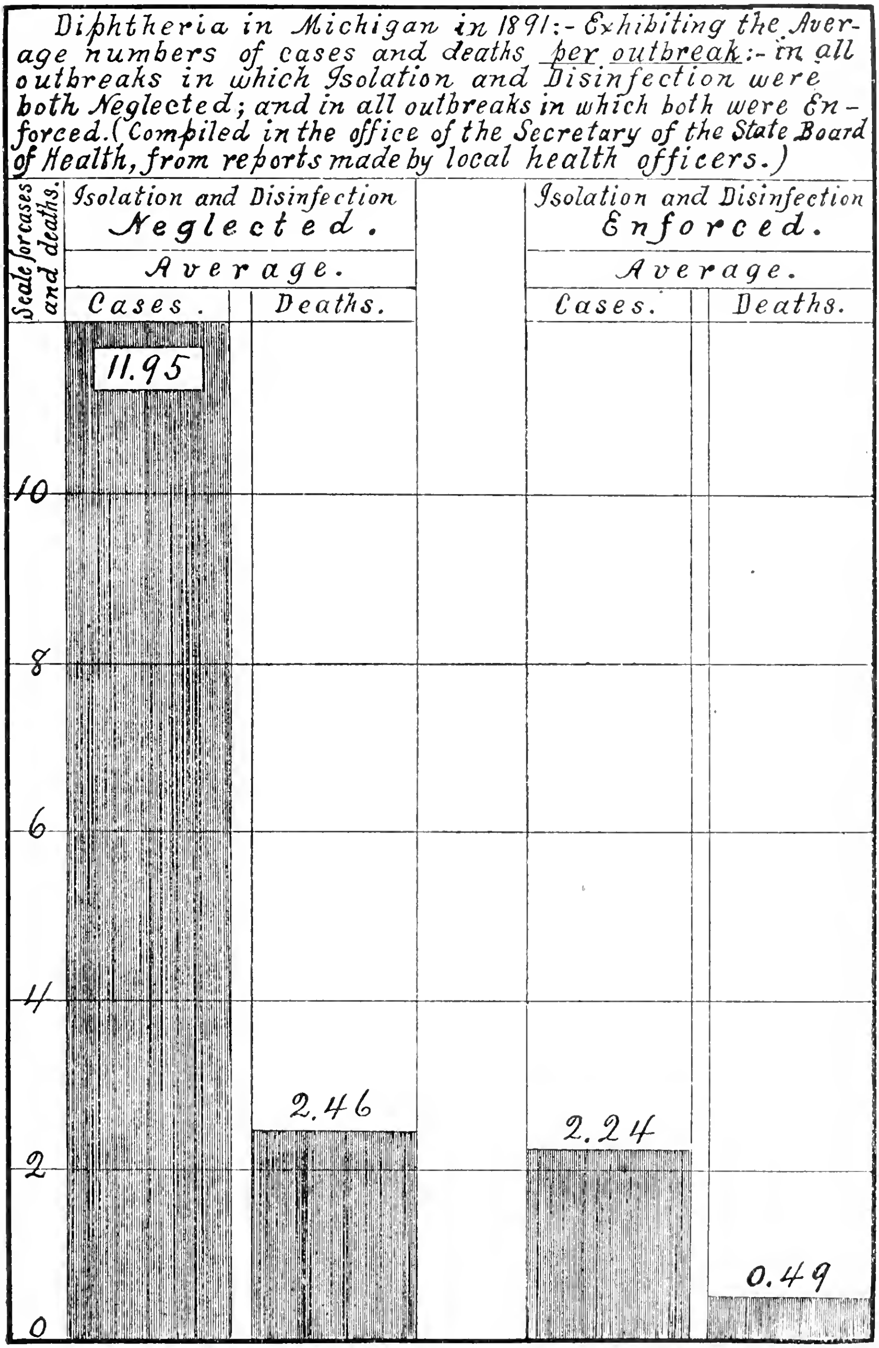
Diphtheria in Michigan in 1891:- Exhibiting the Average numbers of cases and deaths per outbreak:- in all outbreaks in which Isolation and Disinfection were both Neglected; and in all outbreaks in which both were Enforced. (Compiled in the office of the Secretary of the State Board of Health, from reports made by local health officers.)
Scale for cases and deaths.
Isolation and Disinfection Neglected.
Average.
Cases.
Deaths.
Isolation and Disinfection Enforced.
Average.
Cases.
Deaths.
10
8
6
4
2
0
11.95
2.46
2.24
0.49

Plate 537.

# ISOLATION AND DISINFECTION RESTRICTED SCARLET FEVER AND DIPHTHERIA IN MICHIGAN DURING THE 5 YEARS 1886-90.

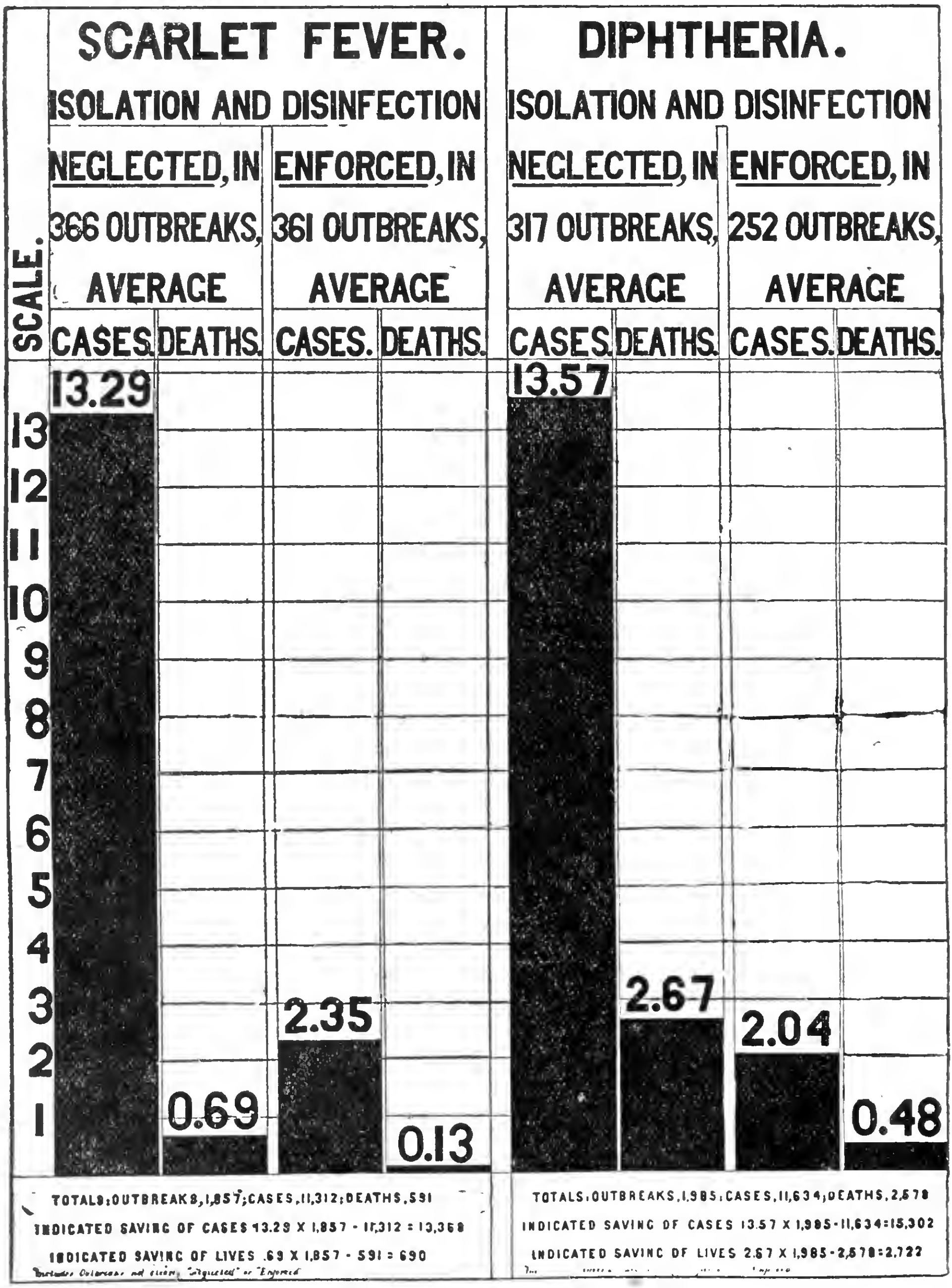


Plate No. 516.

Incidentally, too, a comparison of these two general facts leads to another important fact, namely, that at least four-fifths of the cases of the scarlet fever and diphtheria experienced in Michigan must have been spread directly or indirectly from previous cases. Otherwise they would not be prevented by isolation and disinfection.

Please notice that the results in one year are not very widely different from the results in other years, so that a prophecy relative to the year 1891, for instance, from the experience in preceding years, would have approached the actual experience in 1891.

I think I have now demonstrated that the art of sanitation has now been put upon a scientific basis, that the results are capable of numerical expression, in fact that there is a Science of Sanitation.

# SECOND ANNUAL FIELD MEETING, JUNE 1896.

The second annual field meeting of the Michigan Academy of Science was held at the Michigan Agricultural College, Ingham county, June 13, 1896.

Sixteen members of the Academy were present, together with a number who were not members. Most of the day was spent in roaming about the college grounds, visiting the general museum, the zoölogical and botanical laboratories, the botanic garden, etc., and enjoying a ride over the college farm and through the deep woods.

Some of the members collected shells along the Cedar river, others gathered plants and insects, and all enjoyed the meeting thoroughly. A substantial dinner was served in Abbott Hall, and the business meeting was held there also.

The business meeting was called to order at 1:30 p. m. by President W. H. Sherzer, twelve members present. Formal permission was given for the organization of a Section of Agriculture, in accordance with the request and notice filed at the last regular meeting.

Permission was also given for the formation of a Subsection of Conchology.

The secretary, on written request of Professor Reighard, brought up the matter of subscription to the Huxley Memorial, which was referred to the Council, with power.

After a brief intermission, the Academy was again called to order and informed of the organization of the Section of Agriculture, with Prof. Clinton D. Smith as vice president, and A. A. Crozier, secretary. This organization was approved by the Academy. The report of the Council was read, recommending for resident members the following thirteen candidates who were duly elected:

Luther H. Baker, Lansing; Cheshire L. Boone, Ypsilanti; Leon J. Cole, Grand Rapids; Miss Hester T. Fuller, Greenville; Dr. E. A. A. Grange, Lansing; Thomas L. Hankinson, Agricultural College; Henry S. Hulbert, Detroit; Willard E. Mulliken, Grand Rapids; E. Dwight Sanderson, Lansing; C. F. Schneider, Lansing; Miss Anna A. Schryver, Ann Arbor; Percy S. Selous, Greenville; Prof. Philip B. Woodworth, Agricultural College.

In the absence of Professor Barr, and in view of the small number of members present, it was deemed best not to take action on the proposed amendment to the constitution, notice of which was given by Professor Barr at the last meeting.

## COUNCIL MEETING.

At a meeting of the Council of the Michigan Academy of Science, held at Jackson, February 6, 1897, the following resolutions were adopted:

*Resolved*, That it is the function of the Michigan Academy of Science,

1. To afford opportunities for representatives of the various sciences in the different parts of the State to meet one another socially, to discuss plans for the advancement of the interests of their sciences, and to secure the co-operation of all scientific workers and local associations in the State.
2. To promote in every possible way, as a representative scientific body, any project for the furtherance of the interests of science within the State.
3. To secure, at as early a date as possible, the initiation of biological and other scientific surveys of this State, and to encourage individual and associated effort toward the same end.
4. To stimulate the discussion of the aims and methods of science teaching, with the purpose of unifying and improving the practice of teachers of science in the schools and colleges of the State.

# THIRD ANNUAL MEETING.

ANN ARBOR, MARCH 31, APRIL 1 AND 2, 1897.

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The meeting was called to order at 2:45 p. m., President Sherzer in the chair; about forty persons present. The minutes of the last regular meeting were read, amended, and approved. The minutes of the last field meeting (June 13, 1896) were also read and approved.

The report of the treasurer, Chas. E. Barr, was read, accepted and referred to an auditing committee, which reported later that the accounts were correct.

Twenty new members were elected, as follows:

(Miss) Alice Brown, Ann Arbor; Flemming Carrow, M. D., Ann Arbor; H. H. Chase, Linden; Paul A. Cowgill, Cassopolis; Charles J. Davis, Lansing; Delos Fall, M. D., Albion; Mary E. Greene, M. D., Charlotte; Thomas Gunson, Agricultural College; E. M. Houghton, M. D., Detroit; Burton O. Longyear, Agricultural College; Charles E. Marshall, Ph. B., Agricultural College; J. G. McClymonds, M. D., Ann Arbor; Jason E. Nichols, Lansing; G. D. Perkins, M. D., St. Paul, Minn. (corresponding); Rufus H. Pettit, Agricultural College; Albert B. Prescott, Ph. D., Ann Arbor; (Miss) Harriett Putnam, Saginaw; Herbert E. Sargent, Detroit; F. D. Smith, Greenville; Louis H. Streng, Grand Rapids.

Prof. Jacob Reighard, from the committee appointed by the Council to formulate a by-law relative to the organization of sub-sections, reported as follows:

"No plan which is adapted to all sub-sections seems feasible. We recommend that the organization of sub-sections be left to the members of the section concerned, and that the chairman of each sub-section shall indicate annually what progress is being made." Report accepted and adopted.

The secretary was authorized to make such verbal changes in the constitution and by-laws of the Academy as are necessitated by the change in time of holding the annual meeting.

The following resolution, submitted by Bryant Walker, was adopted and the secretary was instructed to send a certified copy to the postmaster general at Washington:

"*Whereas*, The free interchange of scientific material is of great public utility as aiding in scientific research, and, whereas the rates of postage as now fixed by the Universal Postal Union are excessive and practically prohibit the use of the mails for scientific exchanges, "*Resolved*, That the Postmaster General of the United States be requested by this Academy to instruct the delegate of the U. S. government to the International Postal Congress, about to meet in Washington, to vote in favor of the proposed amendment to Article XIX of the Regulations of the Universal Postal Union, which shall permit specimens of natural history to be sent through the mails at the same rate of postage as samples of merchandise, and that packages be allowed according to the English Parcel Post."

The amendment to the constitution proposed by Prof. Barr at the second annual meeting was adopted. In accordance with this resolution Article IX of the constitution is changed to read: "This constitution may be amended at any annual meeting by a three-fourths vote of all the resident members present," and Chapter IX of the by-laws is changed to read "these by-laws may be amended by a majority vote of the members present at any regular meeting."

The secretary read brief necrological notices of the Honorable Bela Hubbard, Mr. Willard S. Pope, and Mr. Lorenzo N. Johnson, resident members deceased since the last annual meeting of the Academy.

The following resolutions were adopted:

*Resolved*, That hereafter it be the duty of the vice president of each section to present at the annual meeting some paper on the work of the section.

*Resolved*, That the Academy endorse Senate bill No. 121, and that the secretary transmit a copy of this resolution to the chairman of the committee in whose hands the bill now is.

*Resolved*, That the Academy formally meet in Detroit at the time of the meeting of the American Association for the Advancement of Science, and, after transacting any business which may be desirable, adjourn to attend the meetings of that association.

*Resolved*, That we tender our sincere thanks to the regents and faculty and committee of arrangements of the University of Michigan, who have done so much to make this meeting pleasant and profitable.

In the zoölogical section, vice president Reighard appointed a committee consisting of W. B. Barrows, D. C. Worcester and L. Whitney Watkins to look up the subject of bird legislation, and to the same committee was subsequently referred the question of obtaining information about the birds of the state from persons holding licenses to shoot for scientific purposes.

The election of officers for the ensuing year resulted as follows:

President—Volney M. Spalding, Ph. D., Ann Arbor.

Vice Presidents—Sanitary Science, Frederick G. Novy, M. D., Ann Arbor. Zoölogy, Jacob Reighard, Ph. B., Ann Arbor. Botany, C. F. Wheeler, B. S., Agricultural College. Agriculture, Clinton D. Smith, M. S., Agricultural College.

Treasurer—Prof. W. H. Munson, Hillsdale.

Secretary—Walter B. Barrows, S. B., Agricultural College.

On the last day of the meeting, Friday, April 2, at 9:45 a. m., the Academy listened to the address of the retiring president, Prof. W. H. Sherzer, and at its conclusion took up the joint program of the Academy and the Michigan Schoolmasters' Club, the subject being a biological conference or symposium, entitled, *Biological Teaching in the Second-*

*ary Schools—What Should be Taught? How Much and How?* The program was completed at 4 p. m. and the Academy adjourned.

PAPERS PRESENTED AT THE THIRD ANNUAL MEETING OF THE MICHIGAN ACADEMY OF SCIENCE, MARCH 31, APRIL 1 AND 2, 1897.

1. Black Plague. Victor C. Vaughan, M. D., Ann Arbor. Published in Appleton's Popular Science Monthly, May, 1897.

2. Notes and Observations regarding the Habits and Characteristics of the Massasauga, *Sistrurus catenatus*, during captivity. Percy S. Selous, Greenville. Published in Bull. de la Soc. Zool. de France, XXII, pp. 157-161 (1897). Reprinted in full in present report.

3. Newton's Third Law as a Factor in Organic Evolution. Manly Miles, M. D., Lansing. Printed in full in present report.

4. An Ascent of Mt. Ranier. Illustrated Lecture by Professor Israel C. Russell.

5. Comments on the Nature of the work suited to a Botanical Club of an Agricultural College. Wm. J. Beal, Ph. D., Agricultural College. Printed in present report under the title "Suitable Topics for Discussion by Young Members of a Botanical Club."

6. The Mechanism of Root Curvature. James B. Pollock, Ann Arbor.

7. Remarks concerning the Saprophytic Fungi grown in the Vicinity of the Agricultural College. B. O. Longyear, Agricultural College. Published in part in Report State Board of Agriculture for 1897, p. 48. Reprinted in this report.

8. The Russian Thistle and Tumbling Mustard in Michigan. C. F. Wheeler, Agricultural College. Mostly included in the paper entitled "Additions to the Flora of Michigan," Rep. State Board of Agr. for 1898, pp. 82-91.

9. Early Stages in the Development of the Pollen in *Asclepias cornuti*. Fanny E. Langdon, Ann Arbor.

10. A Remarkable Forest in Michigan, not Hitherto Known. S. Alexander, Birmingham. Abstract printed in this report.

11. Some Alpena County Plants Observed in 1896. C. F. Wheeler. Unpublished.

12. Notes on Michigan Mollusca. Bryant Walker, Detroit. Not published.

13. The Shells of the Quaternary Deposits in Huron County. Alfred C. Lane, Houghton, and Bryant Walker, Detroit. To be published in forthcoming report of the Geol. Survey of Michigan.

14. Demonstration of an Apparatus for Mechanically Passing Objects through Fluids of Different Densities. D. C. Worcester, Ann Arbor.

15. The Structure of the Olfactory Lobe of the Sturgeon. J. B. Johnston, Ann Arbor. Published in Zoological Bulletin (Ginn & Co.) Vol. 1, No. 5 (1898), pp. 221-241. Abstract or summary printed in this report.

16. The Peripheral Nervous System of *Nereis virens*. Fanny E. Langdon, Ann Arbor.

17. On the Fertilization of the Eggs of *Unio complanata*. F. R. Lillie, Ann Arbor. Abstract in "Science," March 5, 1897, new series, Vol. V, pp. 389-390.

18. Poisonous Germs found in Drinking Water. J. McClymonds, M. D. Ann Arbor. Abstract printed in this report.

19. Poisonous Germs found in Foods. Miss A. Brown, Ann Arbor.

20. Distinctions between the Typhoid and Colon Bacilli. G. D. Perkins, M. D., St. Paul, Minn.

21. Antitoxins. E. M. Houghton, M. D., Detroit.

22. Results from the use of Antitoxin. Frederick G. Novy, M. D., Ann Arbor.

23. Some Vital Statistics of Michigan. Cressy L. Wilbur, M. D., Lansing. Printed in full in this report.

24. Observations on the Methods of Distribution of the Seeds of some Michigan Trees. Dr. W. J. Beal, Agricultural College. Published under the title "Seed Dispersal," by Ginn & Co., Boston. 1898.

25. The Geographical Distribution of Life in Michigan. Walter B. Barrows, Agricultural College. Unpublished.

26. The Relation of the Academy to the Elementary Schools. Address of the retiring president. Professor W. H. Scherzer, Ypsilanti. Not published.

27. Notes on the Flora of Huron County. Chas. A. Davis, Alma. To be published in forthcoming bulletin of Geol. Survey of Michigan.

28. The Evening Grosbeak in Central Michigan. Chas. A. Davis. Printed in this report.

29. Public Health Service in Michigan. Henry B. Baker, M. D. (Read by title.)

Biological Conference; joint program of the Academy of Science, and Michigan Schoolmasters' Club.

Subject: Biological Teaching in the Secondary Schools—What Should be Taught, How Much, and How?

30. Botany. Paper by Professor C. A. Davis, of Alma.

31. Paper by Miss F. M. Lyon, Chicago.

Discussion opened by Professor V. M. Spaulding of the University.

32. Zoology: Paper by Professor W. H. Munson of Hillsdale.

Discussion opened by Professor W. B. Barrows, of the Agricultural College.

33. Physiology: Paper by Miss Alice Lyon of Detroit.

Discussion opened by Professor W. P. Lombard, of the University.

34. Hygiene and Sanitary Science: Paper by Professor Delos Fall, of Albion.

Discussion opened by Professor Victor C. Vaughan, of the University.

## NOTES AND OBSERVATIONS REGARDING THE HABITS AND CHARACTERISTICS OF THE MASSASAUGA OR GROUND RATTLESNAKE, SISTRURUS CATENATUS, DURING CAPTIVITY.

BY PERCY S. SELOUS, GREENVILLE.

(Read before the Academy, March 31, 1897. Reprinted from Bull. de la Societe de France, vol. xxii, pp. 157-161, 1897.)

Having kept these snakes now for several years—in fact I may say that they have been a hobby with me—I have had considerable opportunity of studying them and their ways. Harmless snakes I had often made pets of both here and in Europe, but without much regard to scientific data; and my first massasauga soon showed me that the habits of the one, were very different from those of the other. The first thing I found out was that cold blooded food in any shape would not be taken and although I have tried a great variety and under all sorts of conditions, I have never yet been able to get a massasauga to touch other than warm blooded prey. I have tried frogs, toads, various snakes, grasshoppers, etc., without avail and although I believe that the massasauga will take living birds, I have never yet succeeded in making them devour anything but mice.

Then again, the mode of seizing is so different. It matters little to a striped snake where it catches a frog; fore or aft it goes down, and there and then and alive. The massasauga on the contrary, if it be hungry, strikes with lightning rapidity, inoculates its victim and as speedily withdraws, at least in the great majority of cases. Once I saw one hold on for a few seconds. In any case the prey is left and after scampering around the cage gradually weakens, totters and succumbs. I have seen my snakes do this scores of times and I can safely state that thirty seconds is a fair average of life for the mouse, after being bitten. The snake seems to have a good idea of how long the mouse will live, which is an advantage if it can keep it in sight, but this it rarely does. As a rule the mouse kicks itself down between the turf sod and the back or front of the cage, tumbles into the water tank or crawls into some crevice.

The snake, however, will ferret it out. Sometimes it reconnoiters a bit, but rarely fails to locate the dead mouse. Now it is often necessary to seize it by the tail or other part than the head, for it is always dragged out again before being absorbed. In case it has not been first seized by the nose it is again released and seized by the nose and I have never yet seen a massasauga swallow a mouse in any other way than by commencing at the nose.

The massasauga according to my observations, must kill its own prey. I have tried mice killed by the cat, often; not a bit of use. I once took a living but injured mouse from the cat and presented it. The snake noticed it, transiently only, and the mouse speedily dying was ignored. Yet a living one introduced directly after was speedily accounted for. I have not noticed any of my rattlers take more than two mice consecutively. As a contrast to this, a striped snake in an adjoining cage, no bulkier than my largest massasauga, though longer, took eight half grown frogs one after the other as fast as it could swallow them, and from its attitude was ready for more. The frogs were Rana pipiens. What was very interesting to me was the way the Sistrurus drinks. As often as not, after absorbing a mouse, the snake goes to the little water tank and lowering its head until within a half inch of the water, commences to lap, exactly after the manner of a cat. The tongue is protruded and drawn back at regular, rather slow intervals, three or four seconds between each lap. I have known them to keep lapping for a couple of minutes in this leisurely way; it is also interesting to see the jaws stretched wide apart two or three times, with a kind of yawning movement and giving a good view of the internal structure of the palate and adjacent parts; also the erected fangs. (The fangs are always erect when the mouth is open.)

On August 7th, last year, six young were born to a pair of my rattlesnakes and a few days after six more to another pair. These little fellows had all shed their skins within a week of their birth and at the time I put them down in the cellar to hybernate, had about doubled in size. So far as I have been able to determine, the massasauga, when not a baby of the year, sheds its skin twice annually; in May and in July. The change appears to be pretty regular. The dates of one of mine in a separate cage are July 28, 1895; May 23, 1896 and July 29, 1896. I shall keep this individual one's time this season.

With regard to the rattles, I have give up trying to find anything further. The one I have had longest, had six pairs when I first took it; it got another pair the same year and has remained in statu quo ever since so far as tail goes, although it has grown prodigiously otherwise.

One thing is rather mysterious to me, I allude to the manner in which the young subsist and grow so rapidly. Mine certainly have not had any nourishment. The mice are always swallowed by the parents. Of this I am positive, and furthermore if they are not, I remove them, for I never allow a mouse to remain in the box unswallowed, dead or alive. I see them absorbed or I take them out. I have seen the young of H. platyrhinus and S. natrix take refuge in the parent's throat. I wonder if this is only done in case of alarm, or whether there may be something in the theory I have, that they may derive nourishment from the old ones in this manner. I tried my best to induce these young snakes to exhibit this trait to me, but without success. I hope to be able to secure an instantaneous photograph.

Whilst on the subject of surmise, one other matter occurs to me. Last summer several massasaugas were killed in Greenville, and closely and naturally perhaps, it was hinted that I had been careless and allowed one to escape, for such a thing had not been known for a long time. But mine were all safe. We all know that snakes and rattle-snakes too, will congregate to den up and that they come long distances and hybernate year after year in the same spot. There is another instinct as firmly instilled as that of migration; that which enables the male to locate the female and at long distances. May this not be the solution of the massasauga being found right in the center of civilization? If a dog or a moth be thus attracted, why not a rattle snake? Unfortunately I had no opportunity of examining the specimens killed, all I could see was the rattles. If they had proved to be males, my theory would have been, in my opinion, considerably strengthened.

In disposition, I have found the massasauga particularly docile. For a dog they appear to have a special antipathy. One of these has only to sniff around the cages to set the whole colony rattling. Their sense of smell appears to be particularly acute and they will detect a dog at the back of the cage directly. For a cat they do not seem to entertain the same dislike.

On the approach of a thunder storm they always become restless and noisy and are excellent barometers in this respect. I have stated before that about half a minute is the limit of a mouse's life after it is bitten. A sheep died in twenty-five minutes and beyond this I have not had any personal experience with regard to the power of the venom. But this was not a captive snake and as the sheep trod on it, it was naturally enraged and without doubt the blow would be given with all the more vehemence and a more copious supply of virus injected.

Last summer I had rather an uncomfortable thing happen. I was skinning a massasauga and wishing to preserve head and fangs, so that I could set it up open mouthed and being also chary of coming in contact with the teeth, for it had been killed fighting and I knew the fangs would have more or less venom on them, I tied a piece of thread around the head to keep it from me and attached it to a nail whilst I pulled gently at the skin. The thread, however, broke and down came the head on my hand inflicting a slight puncture. I did not relish this at all, but set immediately to sucking the place, and for a quarter of an hour or twenty minutes, I do not think I desisted. I never felt the least inconvenience from it, but I shall be more careful in future.

I shall probably be set down as exceedingly foolhardy, but I have several times held a mouse by the tail with my naked hand and allowed my tamest snake to strike it. I do not know that I would do this with them all.

*Addendum:* (November, 1898.)

As before stated my rattlesnakes had fed on mice only, now they take birds with avidity. Some time since, I put a sparrow into the cage containing two of my largest massasaugas. Both struck at it the same instant. I would say here that when a snake strikes a mouse it releases it at once; when it strikes a bird it holds on till it is dead, the reason for which is not hard to see. One struck the bird, the other the other snake.

at the back of the head, and I had some difficulty in getting them apart. The head and neck of the bitten serpent rapidly became swollen, but after a time it subsided, and it seemed little the worse for it. More than once I have seen my snakes throw up pellets of fur and feathers similar somewhat to those ejected by the Raptores.

On July 22, 1897, I was bitten by one of my rattlers. I had long been in the habit of handling several with impunity, but on the evening named, I was routing for one in its blanket to show to some friends, and presumably irritated it, for it struck me on the forefinger. I immediately opened the wound with my knife and sucked vigorously for some minutes, until I thought I must have practically extracted all the venom. I would say here, that what I extracted I swallowed, for I know I didn't spit much. I haven't the least fear of the venom taken internally, so long as there is no abrasion of the lips or mouth parts. I then filled the wound with permanganate of potash, rinsed it out and repeated the operation. This was all I did, and I took no whisky. All the same, I soon began to feel the effects of the poison and was compelled to see a doctor. Strychnine pills at last overcame its potency, but I was just as sick as I want to be, and would not go through a similar experience for a good deal.*

With regard to the snake that was bitten, it could not cast its skin when the time came, and it died. Since then I had an almost exactly similar accident occur, but this time I sucked the wound of the bitten snake and served it the same way as I did my own finger, very much to its disgust, apparently. When the time came for it to shed its skin it had no difficulty in doing so, and did well after.

## NEWTON'S THIRD LAW OF MOTION A FACTOR IN ORGANIC EVOLUTION.

BY MANLY MILES, LANSING, MICH.

(Read before the Academy, March 31, 1897.)

One of the most striking results of progress in the several departments of science is the constantly increasing evidence that they have a common basis in a few fundamental laws of universal application.

Newton's laws of motion and the principle of the conservation of energy appear to be as significant factors in biological activities and processes as they are in the domain of physics.

What Grove termed the "affections of matter" (heat, light, etc.) are resolved by physicists into modes of motion, and physiologists are obliged to consider vital activities in their ultimate analysis from the same standpoint so that matter might be defined as the medium for the transformations of energy in organic as well as in inorganic processes.

*[While these pages were passing through the press, on April 6, 1900, Mr. Selous was bitten on the hand by one of his snakes, a water moccasin, *Agkistrodon piscivorus*, from Florida, and in spite of the immediate care of several physicians he died from the effects of the bite after about fifty hours of intense suffering. Ed.]

The most satisfactory definitions of "life" and "living matter" are alike in making continuous molecular changes in response to external impressions the essential characteristic.

Tseviranus at the beginning of the century defined life as "consisting in the reaction of the organism to external influences," and fifty years later, after an extended discussion of the subject, Herbert Spencer tells us that "the broadest and most complete definition of life will be the continuous adjustment of internal relations to external relations," which is in effect a restatement of the definition of Tseviranus.

Foster, still later, from the standpoint of the physiologist, defines *living matter* as "not a thing or body of a particular chemical composition, but matter undergoing a series of changes" which he likens to a "complex whirl" or an "intricate dance" in which chemical composition and histological structure are the figures, and he compares the whole body of man to a fountain of water. "As the fountain remains the same, though fresh water is continually rising and falling, so the body seems the same, though fresh food is always replacing the old man, which in turn is always falling back to dust, and the conception we are now urging is one which carries an analogous idea into the study of all the molecular phenomena of the body."

From these definitions of life we may look upon biological processes and activities as modes of motion involving transformations of energy in accordance with Newton's third law which must then be accepted as an important factor in organic evolution.

As formulated by Newton, this law appears to be alike applicable to organic and inorganic processes. "To every action there is always an equal and contrary reaction; or the mutual actions of any two bodies are always equal and oppositely directed."

The struggle for existence implies the sum of the actions and reactions of competing species with one another and with their environment, and the fittest to survive are those that most readily conform in habits and requirements to the constantly changing conditions so that an equilibrium in the conflicting forces with which they have to deal may be maintained.

The surviving individuals and species must then be endowed with a plasticity or elasticity of organization that enables them to adapt their functional activities to varying conditions of the environment.

It follows from this that the first step in the development of a new species must be a physiological or functional adjustment of the organs of certain individuals to changes in the environment, and when these functional adaptations are well established by frequent repetition morphological or structural peculiarities may be developed that are recognized as specific characters, but which are in fact manifestations of the functional adaptions that have preceded them.

These preliminary steps in the development of a new species can only be observed in living organisms, and in our laboratory methods of studying dead organisms we may fail to distinguish species that are clearly distinct in habits, functional activities and powers of adaption from their resemblance in external or morphological characters.

In the geographic distribution of species there must be a balance of organisms in conformity with the mutual needs of competing species under the prescribed conditions, as is strikingly illustrated in the results of the introduction of the mongoose in the island of Jamaica. (V. Science, Vol. 5, p. 15, Jan. 1, 1897.)

With the decline and final disappearance of the discomfited species in the struggle for existence from their inability to adapt themselves to the changed conditions they have aided to bring about, there must be an equivalent readjustment of the habits and essential requirements of the fittest to survive to establish harmonious relations with their fellows and the resulting changes in their environment.

The reaction of less favored species to the sum of the influences of their environment and their ultimate decline and disappearance should not be overlooked in the evolution of new species, as the plasticity of organization and powers of adaptation to changing conditions are intensified in the survivors by their exercise, and every element of change tends to a further divergence in functional activities.

From the point of view here outlined the importance of systematic local biological surveys for the solution of problems in evolution cannot be too emphatically urged. The field naturalist should not, however, limit his observations to the identification and geographical range of species. The conditions of environment that have an influence on the distribution and grouping of species should also be carefully noted, and the data obtained by systematic observations in the several departments of botany and zoölogy must then be correlated to obtain consistent views of the fundamental laws of nature in organic evolution.

The field is so broad that a subdivision of labor in special lines of research will be required, but a common purpose should be kept in view with a full recognition of the interdependence of relations in the facts observed in the several lines of investigation.

Lansing, March 22, 1897.

## SUITABLE TOPICS FOR DISCUSSION BY YOUNG MEMBERS OF A BOTANICAL CLUB.

BY W. J. BEAL, AGRICULTURAL COLLEGE.

(Read before the Academy, April 1, 1897.)

In some respects the botany taught in our Agricultural College should be unlike that introduced into a portion of the courses in a university. For example, the young person bent on agriculture or horticulture in any of their departments would not need to spend time in the study of mosses, liverworts, lichens, or algae, or many of the saprophytic fungi. On the contrary, he does need to learn the names and many of the peculiarities of our native and introduced trees and shrubs, the same of the leading grasses, clovers and other forage crops; he needs a familiarity with our weeds, including the seeds of cereals and other field crops, our parasitic fungi, especially those injurious to cultivated crops and weeds of all kinds, and some knowledge of the anatomy and physiology of the higher plants. In a word, he seems to have a greater need of the old fashioned systematic botany than is generally expected in these times in the courses of a university.

Especially should the agricultural student from the start take much pains to become a close and accurate observer of plants in the field, orchard, and garden, in fact anywhere found.

For such a course the electives need not be numerous.

For many years past at the State Agricultural College there has been a Natural History Society with meetings once a month at which the observations reported referred mainly to agriculture, horticulture, botany, zoölogy, and entomology.

A little over six years ago, a Botanical Club was established with meetings in the botanical laboratory three or four times a month. The attendance averages from ten to fifteen, with a membership of about twenty-five.

During these six years of its existence, there have been presented two hundred and nineteen topics. Most of the members are mentally young. I have here a list of seventy-five or more of these topics which seem to be models of their kind for such members to consider. As one of the objects of the State Academy of Science is to encourage young people—or older ones either—to pursue some lines of investigation appropriate to our aims, I thought this list of topics would be interesting to such young workers or members of a young Natural History Society. It may be needless to say that in nearly every instance the paper or talk gave the results of personal observation.

A comparison of the fruits of our three elms.
The Flora of Michigan, some notes on.
Beech drops.
The odor of plants.
The box elder.
Proper work of a botanical club.
Thistles of the neighborhood.
A study of the leaves of Arbor vitae.
Comparison of the buds of several oaks.
The fruit of the red mulberry.
Comparison of the twigs of three pines.
The roots of the red clover.
Pop corn, before and after popped.
The roots and leaves of a young wheat plant.
The report of a field day.
The flowers of Campanula.
The flowers of the common sage.
Petiolar glands.
The life history of corn smut.
Notes on how to observe.
Notes on leaf galls.
The attractions of the botanic garden.
A talk on wheat.
Remarks on native goldenrods and asters.
A comparison of beech nuts from several trees.
Large varieties of fruits of a hawthorn.
Autumn leaves.

How botany is taught at the state university.
Notes concerning Dr. Watson of Harvard, recently deceased.
Detecting the adulteration of buckwheat flour.
A talk on some of our ferns.
A talk on the origin of cultivated plants.
Some of our fresh water algae by an amateur.
A fungus growing from the neck of a larva.
The adulterations of tea.
Observations on the black knot of the plum.
The adulteration of coffee.
Fasciation in a dandelion.
Our erysiphae and their hosts illustrated.
Report of the meeting of the A. A. A. S.
Different forms of leaves on the same plant.
Carnations, structure, etc.—the models.
The "flow" of sap in the sugar maple.
Questions asked of the botanist of the experiment station.
Our willows—illustrated.
Some of our earliest grasses.
The structure of a puff ball.
Plans of some experiments for preventing smut in oats and barley.
How to kill quack or couch grass,—why?
Botany as seen in the German exhibit at Chicago.
Some of the curious plants grown in the greenhouse.
Four persons talked of as many different kinds of smuts.
Our native orchids.
Two kinds of wild potatoes grown in the botanic garden.
Some of the fungi grown on tomatoes.
The cross-fertilization of wheat.
The improvement of our wild fruits.
Some monstrosities among plants and their meaning.
History and development of some of our grapes.
The mode of distribution of some seeds.
Observations on Michigan pines.
The irregularity in the germination of seeds of weeds and the advantage to these plants.
Sub-irrigation in the forcing house.
An exhibit of seedling willows.
Observations on oak galls.
A comparison of plants of wheat and chess.
An exhibit of tomatoes grafted on potatoes, both bearing crops.—double cropping.
Experiments with smut on wheat.
Concerning the State Academy of Science which met at Ann Arbor, June, '94.
A visit to Greenland by one of the founders of the club, Mr. Orth.
An exhibit of fruits of our native trees and shrubs.
A plant of wild strawberry in the botanic garden had produced 1,234 plants.
The structure and use of bulliform cells in the leaves of some grasses.
The structure of root tips of wheat, and some branching hairs.

Squirrels dropping cones from trees and biting off limbs.

Exhibition and description of an artificial cell to show turgescence.

Report regarding the abundance of variegated corn in the field.

The life history of Monilia—plum rot.

An exhibit of chess which had germinated on ice.

An account of cutting wild rice, rafting down the river and curing for hay in '95.

Report concerning a visit to the U. S. Department of Agriculture and the M. A. C. men there employed.

The management of the woodlands of the college farm.

The structure and history of the Navel orange.

Fairy rings on our lawns (Marasmius).

A meeting in the evening at the botanic garden to observe the opening of flowers of the evening primrose and to see insects at work on various flowers.

The crossing of pop corn and field corn.

Life history of rust on wheat and barberry.

The seeds of weeds.

I hardly need to add that any botanical club or natural history club will make slow progress and work to very great disadvantage unless one or more of the members possesses already a very good knowledge of one or more divisions of natural science. If possible, such members will be of more aid in securing interest than a library.

## REMARKS CONCERNING THE SAPROPHYTIC FUNGI GROWN IN THE VICINITY OF THE AGRICULTURAL COLLEGE.

BY B. O. LONGYEAR, AGRICULTURAL COLLEGE.

(Read before the Academy, April 1, 1897, and printed in part in Rep. State Board of Agriculture for 1897, p. 48.)

The study of the saprophytic fungus flora in the vicinity of the Agricultural College was begun in the spring of 1896, first in a rather desultory manner by collecting at random all sorts that were encountered in the brief trips to nearby woods and fields. The specimens, at first, were merely dried and stowed away in boxes with some record of locality and date of collection and left until a more convenient time for study and identification. "It was soon found necessary, however, to observe the color of the spores of the Agaricineæ, and this is best done while the specimens are yet fresh. We have succeeded in securing good spore-prints in the usual manner by carefully removing the pileus and placing it gills down on a piece of gummed paper and covering the whole with a bell jar. The process usually requires from twelve to twenty-four hours. White paper is used for all specimens having colored spores, and black paper for those having white or colorless spores. The moisture of the fungus is usually sufficient to soften the gum on the paper so that the spores are held when dry. The spore prints are also accompanied with drawings of a vertical section of the fungus, thereby showing the width of the gills and their relation to the stipe, besides other features of the specimen which often determine its generic position. Notes are also taken of odor, taste, colors, etc., of the specimen when fresh.

"Our collections are arranged in interchangeable pasteboard trays, one inch deep and varying in size from four and one-half by six to nine by twelve inches. These are temporarily placed in wooden trays which will just contain four of the largest pasteboard trays. We have been able to collect during every month of the year and have secured many specimens of such genera as Polyporus, Polystictus, Fomes, Stereum, Corticium, Peniophora, and allied genera, since the first snow came. Some species of gill fungi also persist throughout the winter ready to take advantage of every warm day. Among the most persistent are those belonging to the following genera: Lenzites, Schizophylum, Pleurotus, Collybia, and Mycena in the white spored, and Crepidotus in the yellow spored sections. The most tenacious species are those that grow on wood. Not a few species belonging to the Hydneæ and Tremellineæ are also available to the winter collector. Among some of the notable specimens which were secured last season may be mentioned a plant of Lycoperdon giganteum weighing, when fresh, seven pounds ten ounces and measuring forty-five inches in circumference, while compared with this are some specimens of Geaster minimus, a star puff ball, weighing only a few grains. The moist, warm weather of 1896 also brought out some very large specimens of gill fungi. Among the attractive species we have a large tray of the bright red Polyporus cinnabarinus, brought from Lewiston, Montmorency county, by Dr. Beal when on institute work. This grows on canoe or paper birch.

"We have between two hundred and fifty and three hundred species of Basidiomycetes, representing ten of the thirteen families of this group and covering nearly seventy genera. The identification of this material is the most serious problem that we have encountered. This is partly due to the meager literature on the subject in the United States. The North American Fungi of Ellis and Everhart have aided us much, and we are also especially indebted to Prof. Chas. H. Peck, of the New York state museum, for the identification of some of this material. The reports of this botanist have been of much assistance to us.

"That this subject presents an economic as well as a scientific side is becoming more clearly recognized. While mushroom eating has been practiced for many years, yet the persons indulging in this semi-hazardous practice almost invariably confine themselves to the ascomycetous morel or the common mushroom, Agaricus compestris. All others are called 'toadstools' and considered poisonous. But the progressive fungus eater will not be satisfied to confine himself to these two forms, but will enlarge his list to at least a score of species suitable to cater to his wants. The gnawed remnants of Polypori found on stumps and logs during the winter seem to attest to the high estimation in which some of these fungi are held by the squirrels. Many pounds of fairy-ring mushrooms, Marasmius oreades, grew on the college campus last season and were eagerly sought for by people from the city of Lansing. No doubt many persons are restrained from the use of these plants as food through fear of the poisonous qualities of certain species; and, while this fear has been a safeguard against accident, it has also been the means of depriving these persons from a food of palatable and highly nutritious qualities. While care is necessary in the collection of mushrooms for food, still one can learn with careful observation to readily discriminate between species so that the deadly Amanita and its noxious relatives may be avoided.

"The handsomely illustrated book, 'Our Edible Toadstools and Mushrooms,' by the late Hamilton Gibson, is doing much toward popularizing the eating of mushrooms among those who have access to the book. The forty-eighth report by Prof. Peck, recently received, should be mentioned in this connection, as it contains many illustrations and descriptions of edible fungi found in the state of New York. A smaller work of similar character by Julius A. Palmer, Jr., is also a desirable book for those wishing to become familiar with the commonest forms of edible fungi. The scientific side of the subject is a field which seems to have been but little worked in our State, although our woods and fields and even our dooryards can furnish abundant material. A surprising number of species can be found in a limited area. Very much the larger part of our collection has been made in a piece of woods about seven acres in extent lying a little north of the College campus. It is our intention to continue making a careful study of these plants in our county and State, and we should be pleased to communicate with persons interested in this subject. We will endeavor to indentify specimens sent us."

## A REMARKABLE FOREST IN MICHIGAN NOT HITHERTO KNOWN TO SCIENCE.

BY S. ALEXANDER. BIRMINGHAM.

(Read before the Academy, April 1, 1897.)

(Abstract.)

At Birmingham, Oakland county, in 1895, I found an oak tree nearly four feet in diameter and one hundred feet high, the leaves and fruit of which resembled *Quercus prinoides* and *Q. acuminata*. Later many other large trees were found. After seeing specimens, Prof. Sargent concludes that it is *Quercus acuminata*, although the bark differs from that usually found on this species. On studying numerous specimens from this and other trees of the neighborhood, G. B. Sudworth pronounces it *Quercus prinoides*, although this species has heretofore been known as a shrub five to fifteen feet high. Mr. Sudworth notes that different trees of some species of oaks vary much and are difficult to identify, but he can see no reason for suspecting a new species in this specimen.

Dr. N. L. Britton, on first examination in the field, believed it was a new tree, possibly *Quercus Michauxii*, but later he decided it could not be that species.

## STRUCTURE OF THE OLFACTORY LOBE OF THE STURGEON.

BY J. B. JOHNSTON, ANN ARBOR.

(Read before the Academy, April 1, 1897. Summary, reprinted from Zoological Bulletin, Vol. 1, No. 5, p. 240.)

### Summary of Results.

*A.* The olfactory lobe:

(1) In addition to mitral cells of two sorts, six other forms of cells, concerned in receiving and transmitting olfactory impulses, are found in the olfactory lobe.

(2) The granule cells are provided with axis cylinders and glomerular dendrites, and are therefore nerve cells.

(3) The olfactory lobe contains cells which are morphologically identical with the cells of Cajal.

(4) The glomerular zone of the olfactory lobe contains cells with short axis cylinders (associational cells).

(5) The large mitral cells are provided with non-glomerular dendrites.

*B.* The fore-brain:

(6) There is in the dorso-median region of the fore-brain a large incompletely differentiated nucleus of cells with short axis cylinders, constituting an imperfect epistriatum.

(7) A group of cells is found on the lateral surface of the fore-brain which agrees in position and apparently also in connections with the cortex lateralis of *Reptilia*.

(8) The cortical region of the fore-brain is connected with the ganglion habenulae by a tractus cortico-habenularis. A tractus olfacto-habenularis is also present.

*C.* The habenular tracts:

(9) Meynert's bundles do not end in the corpus interpedunculare, but undergo partial decussation there and pass on toward the medulla.

## POISONOUS GERMS FOUND IN DRINKING WATER.

BY JULIAN T. McCLYMONDS, M. D., ANN ARBOR.

(Read before the Academy, April 1, 1897.)

(Abstract.)

Since Hippocrates wrote on air, waters and places, water as a cause of disease has been given a prominent place. The first experiments proving the correctness of this belief were made by Pasteur, in 1878, when he inoculated animals with polluted water causing death with symtoms of septicemia. Three years later Gaffky carried out similar experiments and isolated the bacillus of rabbit septicemia. Mori in 1888, using water from the Berlin canals, obtained from the bodies of animals dying from the inoculation, the bacillus of mouse septicemia, the short canal bacillus and the capsulated bacillus.

Koch's discovery of the spirillum of Asiatic cholera in 1884 and Michael's isolation of the bacillus of Eberth from a well in Grossburck, 1886, clearly established the causal relation of water to diseases in man.

While nearly all the pathogenic bacteria have been found in water, but three, the spirillum of Asiatic cholera, the bacillus of Eberth, and the bacterium Coli Communis, have great practical importance. The detection of the cholera and colon germs is a matter of comparative ease. Unfortunately it is otherwise with the Eberth bacillus and its isolation from drinking water is one of the most difficult problems with which the bacteriologist has to deal.

During an outbreak of typhoid in Budapest, lasting for three months and over, one thousand cases coming down, Fedor made hundreds of examinations and succeeded in isolating the bacillus but five times.

From two thousand examinations made by Kawalski in Vienna, but five gave positive results. In the hundreds of examinations made in the laboratory of hygiene, many of them with suspected waters, the bacillus of Eberth has been found but once.

This lack of success is in part explained by the following:

(1) The slow growth of the bacillus in water, at the usual temperature, compared with ordinary water bacteria.

(2) Its short life in water, especially water rich in non-toxicogenic bacteria and other lower forms of vegetable and animal life.

(3) Their unequal distribution.

(4) The germicidal action of light.

(5) The sedimentation of bacteria.

(6.) The presence, usually in far greater numbers of Colon germs. Many special methods have been devised to overcome some of these difficulties. (1) Rodet added the water to bouillon and heated it from 45° to 45.5° C. for ½ to one hour. (2) Chantimesse and Widal employed a .25% carbolic acid gelatin. (3) Virricent used five drops of a five per cent solution of carbolic acid to 10 c. c. bouillon and incubated at 42° for twenty-four hours. These methods are faulty in that they often destroy the Eberth bacillus. (4) The method of Parrietti has been widely used and has given fair results. To tubes containing 10 c. c. bouillon is added 1-10 2-10 3-10 c. c. of Parrietti solution.

| | | |
|---|---|---|
| Carbolic acid | 5 | grammes. |
| Hydrochloric acid C. P. | 4 | grammes. |
| Distilled water | 100 | grammes. |

The tubes are incubated at 37° for twenty-four hours, then to each tube is added ten drops of the suspected water, and the tubes again incubated. If growth takes place, indicated by the turbidity of the bouillon, the bacillus of Eberth was said to be present.

As now employed the bacillus must be obtained in pure cultures and grown on various media. (5) Wašbutski examined larger quantities of water by adding to it sufficient of a nutrient solution containing 10% each of glucose, peptone and sodium chloride to make a 1% solution.

This he incubates at 37% for four to six hours, when he finds the Eberth bacillus, if present, enormously increased. He suggests the solution be made slightly acid with Parrietti solution.

The method used in the hygienic laboratory was devised by Doctor Vaughan in 1888, previous to the work of Rodet.

(1) The water for examination must be sent in sterile bottles.

(2) Three to four gelatin plates are made from one drop of the water.

(3) Tubes of beef tea are inoculated with 10, 20 and 60 drops of water and incubated at 38° to 39° C. for twenty-four hours.

(4) If no growth occurs the water is pronounced safe as it contains no bacteria capable of growth at body temperature.

(5) If growth occurs, plates are made from tubes by Koch's method and animals inoculated intra-abdominally with one-half to one c. c.

(6) Animals dying from inoculations are posted and plates made from abdominal organs. Smears and hanging drop are made.

(7) Colonies developing on plates made from water, beef tea and abdominal organs are studied, pure cultures made and bacteria classified.

(8) If animals are unaffected by inoculations the water can be pronounced safe; in case animals die the water is condemned.

Two groups are made of the germs found: 1. Those resembling the bacillus of Eberth, the typhoid group, and those resembling the Bacterium coli communis, the colon group. It is only in the method of distinguishing these groups that any change has been made in the original method.

For their differentiation we rely upon: 1. The coagulation of milk. 2. The Indol reaction. 3. The production of acids as shown by litmus gelatin.

These tests are positive for the colon group, negative for the typhoid group.

In the coagulation of milk we have one of the best methods for the separation of the typhoid group from the colon group when on the same plates, the appearance of colonies being often so atipical as to be of little value. Twenty or more tubes of sterile milk are inoculated from the colonies and these incubated for twenty-four hours at from 37° to 38°. Tubes not coagulated contain the typhoid group.

During the past year I have isolated nine bacteria belonging to the colon group, two belonging to the typhoid group, differing in some respects from the bacillus of Eberth, and from one water the bacillus pyocianeus.

## SOME VITAL STATISTICS OF MICHIGAN.

BY CRESSY L. WILBUR, M. D., LANSING.

(Read before the Academy, April 1, 1897.)

Lord Bacon, the apostle of modern inductive science, has said: "The true greatness of a state consisteth essentially in population and breed of men." If this aphorism be true, then it must follow that exact knowledge of the character of the population of Michigan and its quantitative and qualitative fluctuations must be of interest to all loyal and intelligent citizens of the state, and of direct value to all workers for the common weal, whether in her legislative halls or in the quieter but oftentimes more effective spheres of private influence.

Such knowledge may be derived, to a very considerable extent, from the "Vital Statistics of Michigan," published annually by the Secretary of State. I wish especially in this paper to call the attention of the members of this scientific society to certain conclusions presented in the last published report (that for the year 1894) which have a very direct and important bearing upon the probable future condition of our state, at least so far as regards the source of its population in the years to come. Indeed, the data presented have a broader meaning and one not solely applicable to the future of our own state; they may be taken, it is believed, as an index of the prospects for the continuance of the native American race in this country.

I shall not pause here to answer the sneer that an editorial writer in a leading state journal threw upon discussions of this character and upon vital statistics in general. He said, after ridiculing certain alleged statistical absurdities that were purely of his own imagination, referring to the statistics of births: "Even if the state were engaged in scientific stirpiculture—as it is not—the facts could hardly be regarded as having any definite value." To a body of men accustomed to regard every new fact in nature as of precious importance, even though its practical or economic application may be unknown, such an objection will have little weight. But it is no less true in sociology than in science generally that abstract knowledge may be the forerunner of many unforeseen applications in daily life and use, and the sort of knowledge of the movement and destiny of the American race that these statistics reveal may yet have a direct influence in modifying the current of our national life.

The following tabular comparison presents the fecundity of marriage in Michigan for native and foreign-born mothers for four consecutive quinquennial periods, extending from 1875 to 1894. It is necessary in computing the fecundity of marriages to compare the children born in one period with the marriages in the preceding period, so that the data really extend from 1870 to 1894 and include twenty-five years of registration. Nearly a million births and nearly four hundred thousand marriages are represented in this table for Michigan, so that the statistical basis is amply large for satisfactory conclusions. As to the technique employed, the necessary allowance for imperfect returns in certain respects, etc., the original report may be consulted, where the method employed is fully explained. It may be said in corroboration of the conclusions given in this table that results obtained from a special inquiry by the last state census, and which were not available until after the report was printed, closely agree with it.

*Fecundity of marriage in Michigan.**

| Five-year periods. | Children born per marriage, with mother— | |
|---|---|---|
| | Native-born. | Foreign-born. |
| 1875-79 | 3.6 | 5.8 |
| 1880-84 | 3.3 | 6.5 |
| 1885-89 | 3.0 | 4.9 |
| 1890-94 | 3.0 | 5.1 |

*Twenty-eighth Annual Registration Report of Michigan, 1894, p. 119.

*Children to a marriage in various countries.*

| Country. | Children to each marriage. | Country. | Children to each marriage. |
|---|---|---|---|
| Russia in Europe, 1888 | 5.7 | Victoria | 4.2 |
| Ireland | 5.5 | Belgium | 4.2 |
| New Zealand | 5.2 | England | 4.2 |
| Italy | 4.6 | Sweden | 4.0 |
| Scotland | 4.4 | Denmark | 3.6 |
| Holland | 4.3 | France | 3.0 |

It is scarcely necessary to expatiate on the above statistics. The figures speak for themselves. There has been some decline in the rates of fecundity, both for native and for foreign-born mothers, in the successive quinquennial periods, but the relative rates have remained about the same. About three-fifths as many children are born to native women as to foreign women in proportion to the number married. The significance of the low rate of fecundity reached by the native-born women of Michigan appears further from comparison with the corresponding rates of European countries, and especially with that of France. The population of France is now stationary, or even decreases in certain years; the normal natural increase of population depending upon the excess of births over deaths has almost entirely disappeared. The attention of French demographers has been emphatically called to the condition existing, and French patriotism has been excited, for it is certain that France, if her population fails to increase while that of Germany continues to augment in the usual ratio from year to year, will never be able to avenge Sedan, nor even to long retain her place as a first-rate European power.

Now the fecundity of the native-born women in Michigan is the same as the fecundity of the women of France. If that fecundity is unable to maintain the French people intact, then it is highly probable that the native inhabitants of Michigan are failing to hold their own. The comparison would be even more disadvantageous to the natives if pure native stock were included only under that term. By "native-born women," the descendants of foreigners in the first generation are included in part, and it is probable that the birth-rate of this class is higher than that of the Americans of longer residence in this country.

The fact that the present fecundity of the native population of the state is insufficient to maintain it intact, will also appear from direct consideration of the figures. Two individuals are merged in the family, and in time are removed by death, their places being made good by their children. It is evident that the average number of children per marriage must be sufficiently great to enable at least two children to survive to maturity in order to maintain the population in a stationary condition. The losses by death of infants and children before reaching reproductive years are very large. Moreover, under our social conditions, very many adults, and perhaps an increasing number, refrain from marriage. The ratio given in the table, 3.0 children per marriage, may be slightly understated on account of the prevalence of divorce, whereby the same woman may appear in the records of marriages several times, but on the whole it seems clear that the margin of one child per marriage is insufficient to repair the losses indicated and leave the native population of the state intact.

It will be noted that the decline in fecundity through the four quinquennial periods is comparatively slight, being only from 3.6 children per marriage to native women in 1875-79 to 3.0 in 1890-94. I believe, although I have no statistics to prove it for Michigan as our registration records began in 1867, that the great decline in the fecundity of native marriages took place in the preceding generation. Not the fathers but the grandfathers of the present generation of Americans were men of large families.

The native American race, comprising largely the descendants of settlers from New England and New York, has played a large and important part in the development of the state, and has impressed upon its institutions those characteristics that stamp it as one of the states in the union most typically representative of true American ideas. Even today nearly ten per cent of the population of the state were born in New York. The splendid school system of Michigan, her courts of justice and public institutions, her magnificent record in the civil war, —all these speak in emphatic tones of the worth of that "population and breed of men," the native American citizens of the state, which is now giving way, so our statistics indicate, to the recent immigrants and their descendants.

About three-fifths of the present population of Michigan are either foreign-born or the children in the first generation of foreign-born parents. And our cities are even to a greater degree so constituted, nearly four-fifths of the inhabitants of Detroit being of foreign birth or parentage.

The present paper has not been presented from the standpoint of an alarmist, but simply that the attention of the members of the Academy might be called to the data bearing upon the important social changes now proceeding in the state. No consideration will be paid to the causes and probable consequences of the variations in the constitution of the population. I only hope that the statistics presented may seem worthy of further study, and that they may thus incidentally call attention to the valuable resources now available in the official vital statistics of the state for better knowledge concerning the constitution and tendencies of our people.

## THE EVENING GROSBEAK IN CENTRAL MICHIGAN.

BY CHARLES A. DAVIS, ALMA.

(Read before the Academy, April 2, 1897.)

In the early part of 1890, the writer's attention was attracted to a flock of birds of considerable size, conspicuous coloring and loud clear notes which were noticed first in a small grove of beech and maple trees near the College. Their notes were strange, consisting of a loud, clear, short whistle, often repeated, and unlike the notes of any of our native birds. It did not take long to secure specimens, for the birds were exceedingly tame and unsuspicious, evidently being entirely unfamiliar with man and his weapons. The species was easily determined to be the Evening Grosbeak, *Coccothraustes vespertinus*, that rather rare migrant from the great northwest. The flock was a large one, consisting, when first noted, of two or three hundred individuals, possibly more, for it was larger at some times than at others. The birds had a habit of visiting the grove where they were first noted and spent a portion of every day there, usually the morning, feeding on the ground or perching about in the taller trees. This flock remained in the neighborhood of Alma until May, but the numbers gradually decreased, until but few individuals were left. The decrease was partly due to the fact that many were shot, and partly also to the withdrawal of small flocks from time to time. The species was reported from Saginaw as being abundant there during this season, disappearing in May as it did from the vicinity of Alma.

The species was not again observed about Alma until March 19, 1897, when a small flock of perhaps fifty individuals again appeared in the grove which they had before frequented. At this time it was noted that they spent a considerable portion of the time on the ground picking up the fruits of the hard maple, of which there had been an abundant crop the fall before. The birds came and went almost always in a flock, calling back and forth as they flew, in their peculiar full whistle. The feeding time at this spot was almost invariably during the forenoon.

Addendum:

This flock did not decrease so rapidly as the former one, and finally left on May 8, 1897.

On April 6, 1899, two or three straggling specimens of this species were seen in the same locality where they appeared before, but were not seen nor heard of again.

## THIRD ANNUAL SUMMER MEETING.

DETROIT, AUGUST 10, 1897.

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The third annual summer meeting of the Academy was held at the high school building, Detroit, on the afternoon of August 10, 1897.

The meeting was called to order at 4:30 p. m., by the president, Prof. Volney M. Spalding, and the minutes of the last regular meeting were read by the secretary and approved.

Owing to the absence of a quorum of the Council, no report was presented from that body, and no new members could be elected.

An informal report by Dr. W. J. Beal of the legislative committee, explained the failure of the bill which it had been hoped would authorize the printing of the Academy's proceedings.

Owing to the small attendance no attempt was made to transact further business, and the Academy adjourned to attend the meeting of the American Association for the Advancement of Science then in session in Detroit.

# FOURTH ANNUAL MEETING.

ANN ARBOR, MARCH 30, APRIL 1 AND 2, 1898.

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The fourth annual meeting of the Michigan Academy of Science was held at the University of Michigan, Ann Arbor, beginning Thursday, March 31, 1898. The academy was called to order at 9:30 a. m by vice-president, Jacob Reighard, and the minutes of the last regular meeting were read and approved.

The report of the treasurer, W. H. Munson, showed a balance on hand of $128.30. The report was referred to an auditing committee and approved.

New members were elected as follows:

*Resident Members:*

(Mrs.) Laura E. Burr, Lansing.
Horatio N. Chute, Ann Arbor.
Wm. Mumford Gregory, East Tawas.
Asa Edson Mattice, Concord.
(Miss) Louise Miller, Detroit.
Charles E. Miller, Jr., Grand Rapids.
Norman B. Sloan, Flint.
Edward H. Stein, Grand Rapids.
Eugene Straight, Howard City.
David Trine, Lansing.

*Corresponding Member:*

H. A. Mumaw, M. D., Elkhart, Indiana.

Important changes in the constitution and by-laws of the Academy, recommended by the Council, were adopted, as follows:

1. Making date for balancing treasurer's accounts the first day of the annual meeting.
2. Providing that the president, vice presidents, secretary, treasurer, and editor, shall be elected annually and be eligible to re-election without limitation.
3. Providing that four members shall constitute a quorum of the Council.
4. That all past presidents are members of the Council.

5. That officers shall be elected at the annual meeting and enter on their duties at the end of the meeting.

6. The Council shall nominate a candidate for each office, but each Section may recommend to the Council a candidate for its vice president. Additional nominations may be made by any member of the Academy.

The secretary read a necrological notice of Dr. Manly Miles, of Lansing, a charter member of the Academy, who died February 15, 1898. Mr. Bryant Walker made further remarks on the character and work of Dr. Miles.

It was voted that one thousand copies of Dr. Volney M. Spalding's presidential address, entitled "A Natural History Survey of Michigan," be printed and distributed by the secretary to members of the Academy, and to others in his discretion.*

In the absence of Dr. Spalding, who was too ill to be present at the meeting, Professor Chas. A. Davis explained his views as to a preliminary forestry survey, and after some discussion it was voted that Dr. V. M. Spalding be chairman of a committee which should prepare for the signatures of the members of the Academy a petition that the U. S. Department of Agriculture should take steps to send a special commissioner to investigate the forestry problem of Michigan.

Dr. Lucius L. Hubbard, State Geologist, in response to requests, explained the value and importance of a careful survey of the State, and exhibited samples of the maps made by the U. S. Geological and Geographical Survey.

Officers were elected for the ensuing year as follows:

President—Henry B. Baker, M. D., Lansing.

Vice Presidents—Botany, Charles F. Wheeler, Agricultural College; Zoölogy, Jacob Reighard, Ann Arbor; Sanitary Science, Delos Fall, M. D., Albion; Agriculture, Clinton D. Smith, Agricultural College.

Secretary—Walter B. Barrows, Agricultural College.

Treasurer—W. H. Munson, Hillsdale.

PAPERS PRESENTED AT THE FOURTH ANNUAL MEETING OF THE MICHIGAN ACADEMY OF SCIENCE, MARCH 30, APRIL 1 AND 2, 1898.

1. Spanish Colonial Administration. Illustrated lecture (stereopticon) by D. C. Worcester, A. B. Not published.

2. Methods of Plankton Investigation. Jacob Reighard, Ph. B. Published in full in Bull. U. S. Fish Commission, Vol. XVII, pp. 169-175.

3. Factors in the Origin and Distribution of Species of Land Birds in Island Groups. D. C. Worcester, A. B. Published as part of "Contributions to Philippine Ornithology." Proceedings U. S. Natl. Museum, Vol. XX (1898), pp. 567-625.

4. Milk Fat in Comparison with Meat Fat and Seed Fats. Albert B. Prescott, M. D., LL. D. Annual Report Mich. Dairy and Food Commissioner for 1899.

5. A Word for Systematic Botany. W. J. Beal, Ph. D. Not printed; abstract on a following page.

6. A Contribution to the Knowledge of the Flora of Tuscola and Huron Counties. Charles A. Davis. Published in full in Botanical Gazette, 1898, p. 453. Abstract in this report.

7. How Palm Seedlings Appropriate Their Food. F. C. Newcombe, Ph. D.

8. Development of the Seed of *Gossypium herbaceum*. A. Van Zwaluwenburg.

9. Concerning Some Michigan Plants. Charles F. Wheeler, B. S.

10. The Morels Collected at the Agricultural College. Burton O. Longyear.

11. Recent Investigations of Unicellular Algae. Julia W. Snow.

12. Morphology of the Flower of *Cypripedium*. Burton E. Livingstone.

*The address was printed as directed and copies may be obtained from the secretary.

13. The Distribution of the Unionidae in Michigan. Bryant Walker. Published by the author.
14. A Leaf-miner in Water Lilies. Rufus H. Pettit, B. S. Printed in this report.
15. Some Modifications of the Zeiss Microphotographic Apparatus. Jacob Reighard, Ph. B. Published in present report under the title "Apparatus for Photographing Vertebrate Embryos."
16. The Habits of *Euclemensia bassettella*, a True Parasite Belonging to the Lepidoptera. Rufus H. Pettit, B. S. Printed in this report.
17. On the Effects of Temperature on the Development of Animals. F. R. Lillie, Ph. D. Published (in conjunction with F. P. Knowlton) in Zoölogical Bulletin (Ginn & Co.,) Vol. I, pp. 179-193.
18. The Hind-brain and Cranial Nerves of Acipenser. J. B. Johnston. Published in Anatomischer Anzeiger, XIV Band, Nr. 22 and 23, 1898, pp. 580-601. Reprint of summary of results in this report.
19. Origin and Structure of the Cell Plate. H. G. Timberlake.
20. A Natural History Survey of Michigan. Presidential address. Volney M. Spalding, Ph. D. Published by the Academy, 1898. (Copies may be obtained from the Secretary.)
21. Nature Study in the Common Schools. W. J. Beal. Ph. D. Substance printed in a series of eight bulletins published by the Agricultural College under the heading "Elementary Science."

## A WORD FOR SYSTEMATIC BOTANY.

BY W. J. BEAL.

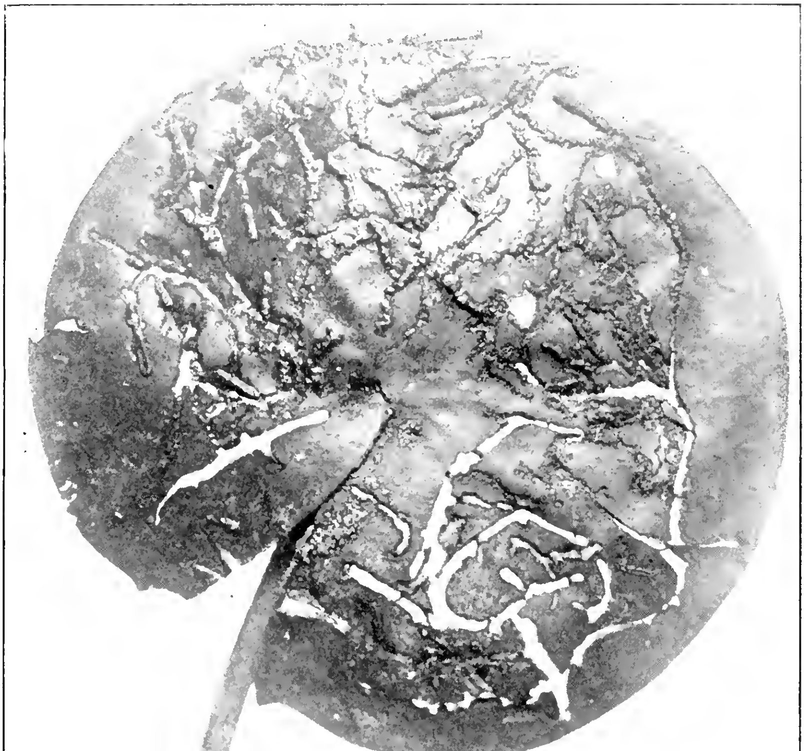
(A brief abstract.)

The author believes that most students acquire a first love for botany by rambling over the fields, through forests and swamps. This brings them in contact with a great variety of plants in various stages of growth and arouses their curiosity to learn their names and places in the plant kingdom, and incidentally they desire to learn their habits and peculiarities. Any young person is sure to have his interest awakened, if he is accompanied by a congenial friend who is a botanist.

## A LEAF-MINER, *CHEIRONOMUS SP.*, IN WATER LILIES.

BY R. H. PETTIT, AGRICULTURAL COLLEGE.

So far as is known to the writer, the members of the genus Cheironomus are tube-builders in their larval stages. They are small flies closely resembling mosquitoes and the larvae inhabit the water where they act the part of scavengers. These larvae are usually blood-red in color and very small and slender, rarely exceeding ⅜ of an inch in length. They build tubes out of particles of vegetable matter and carry these tubes about with them much as do caddice-flies. However, if at any time the larva wishes to leave his dwelling he does so and if, after wandering about for a time, he is unable to find his home, he soon builds another just as good. This seems to be the general habit of the members of the genus. An exception was found last summer in which the larvae made tubes but built them of fresh green material and made them fast in a furrow or minute ditch cut in the upper surface of a water-lily leaf.



LILY-PAD SHOWING WORK OF CHEIRONOMUS SP?

On May 15, 1897, Professor Wheeler called the attention of the writer to the damage being done to water-lily pads in the wild-garden. The pads of both *Nuphar advena* and of *Nymphea odorata* were furrowed by some miner. The pads had been badly eaten in some places and many contained living larvae and pupae. A quantity were collected and placed in cages; after two or three days the adults emerged. The following is taken from notes made at the time.

The insect works by tunneling or plowing a furrow which extends from the top of the leaf to the lower epidermis. This tunnel is often several inches in length and winds about in all directions in a serpentine manner. At the end of the tunnel in which the insect is feeding is a tube made of fresh green parenchyma from the leaf, this is chewed up fine and bound together with silk. From the front end of this tube the insect extends its head and feeds; the tube is fast in the furrow and is not drawn along like a true case as was suspected.

The pupae are partially active and lie in the tubes with the head toward the front. They are light apple-green in color as are the larvae, but both have wine-colored spots or patches of irregular form and indefinite in position in the different specimens.

After two or three days from the time the pads were placed in the cages the adults commenced to emerge. They belong to the genus *Cheironomus* and are probably a new species. The color is uniform light apple green.

On August 1 a second brood was seen at Pine Lake, Ingham county.

## APPARATUS FOR PHOTOGRAPHING VERTEBRATE EMBRYOS.

BY JACOB REIGHARD, ANN ARBOR.

The purpose of the apparatus is to secure the greatest possible depth of focus with a magnification of ten to twenty diameters. For this purpose a low power lens (80mm. Leitz) is used on a long vertical camera.

The large photomicrographic camera of Zeiss, which may be extended to about five feet, is attached to the wall in a vertical position. The microscope is clamped to a bed plate which is provided with levelling screws, so that the optical axis of the microscope may be made coincident with that of the camera.

Attached to the wall alongside the camera is a vertical metal rod which bears at intervals large milled heads by means of which it may be rotated. The lower end of the rod is connected by means of a bevel gear and two Hookes' keys, to a pair of grooved brass wheels which are supported by a pillar that rises from the bed plate. From these wheels cords pass over the coarse adjustment screws of the microscope. The cords may be tightened by adjusting the grooved wheels along a horizontal rod. By this arrangement it is possible to focus with the coarse adjustment, with the camera bellows fully extended.

The embryos (Amia) are attached by collodion to discs of cardboard and photographed by light focused upon them nearly horizontally from a 90 degree arc lamp.

In order to soften the deep shadows on the embryo a circular cardboard reflector one-third of an inch in diameter is used. This is attached to one end of a two inch piece of lead wire, the other end of which rises from a heavy base of brass or lead one inch square. The lead wire has no "spring." The reflector may thus be bent into any position and will remain there when the wire is released.

In some cases the image of the object on the glass screen has no feature sufficiently distinct to permit of focussing. In such cases I have found it possible to focus by placing on the surface of the embryo a fine hair from a sable brush. The hair is clamped into the split end of a lead wire supported on a base like that used for the reflector. By bending the wire the hair may be brought into position and one may focus it. The wire affords a convenient means of removing the hair before exposure.

Zoölogical Laboratory, University of Michigan.

## THE HABITS OF *EUCLEMENSIA (HAMADRYAS) BASSETTELLA*. A TRUE PARASITE BELONGING TO THE LEPIDOPTERA.

BY R. H. PETTIT, AGRICULTURAL COLLEGE.

Several of the orders of insects are well known to include species having parasitic habits. Diptera, Coleoptera and Hymenoptera furnish numbers of interesting forms. While there are several thousand parasites in the three orders named, the order Lepidoptera contains but very few instances to the knowledge of the writer. They are so little seen that a short description of one of them may be of interest.

During the spring of 1896, at St. Anthony Park, Minnesota, a number of specimens of *Kermes* (a gall-like coccid or scale-insect) were collected and placed in a tight tin pill-box for the purpose of rearing any parasites that might be present. In the autumn of the same year this box was opened and the contents examined. Two specimens of a small Tineid moth were found lying dead on the bottom of the box. As this was entirely new to the writer it was the cause of speculation as to how the moths came there. The tin box was carefully examined and found to be intact while it was certain that there were no occupants other than the Coccids in the box when put away in the autumn. An examination of these Coccids showed two of them to be punctured, each by a small hole which was about the right size for the moth to make its exit. A closer examination revealed the fact that one of the openings was provided with a door of circular form which had been cut in the shell of the Coccid and pushed out from the inside so that it remained fastend by a hinge on one side. The inner side of this little door had many scales adhering to it and these scales corresponded to the scales on the moth.

To make the matter clearer one of the Coccid shells was opened and a cocoon containing one of the empty pupal skins was found inside. The brown silken cocoon occupied about one-third of the space inside the shell to which it was attached, being curved, on account of its cramped quarters, into a crescentic form. At the end of the cocoon was found the

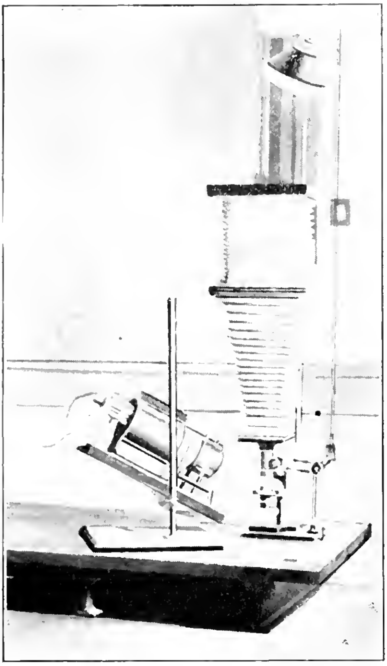


FIG. 1. SHOWING THE ENTIRE APPARATUS. At the left is the arc lamp with condenser, the whole on an adjustable support. At the right the microscope on its base plate and the camera. At the right of the camera the vertical focussing rod. The whole apparatus stands on a platform, supported from the brick wall.

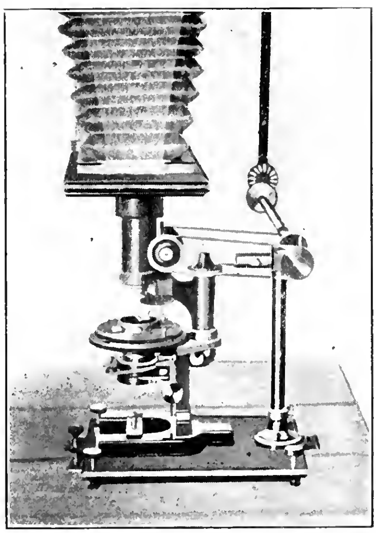


FIG. 2. SHOWS DETAILS OF THE BASE-PLATE AND OF THE FOCUSSING DEVICE. On the stage of the microscope is a brass pan which contains the specimen immersed in fluid. The reflector and support for hair are also seen on the stage. Two Hook's joints (not shown in the figure) are interposed in the horizontal rod which connects the bevel gear with the right-hand pulley-wheels.

opening through which the moth emerged and inside this cocoon was to be seen the amber-brown pupal skin which fitted the cocoon quite snugly.

It would seem impossible that the larva of the moth had hidden in the dead Coccid shell merely to pupate, for no opening of any size was to be found except the one through which the adult insect emerged and this was plainly made from the inside. There was, however, a small scar on the side of the shell very near its attachment to the wood and the shell was very thin at this point. It is probable that through this place the larva obtained entrance and as the Coccid was at this time full-grown, it was unable to heal the wound completely, so the shell always remained thin at this point.

Since that time examples of the Coccid containing the larva have been found, but unfortunately no attempt was made to preserve them because at that time the writer was just on the point of moving and in the consequent hurry the material was lost.

The following original description was taken from "Tineina of N. A. by B. Clemens" being a collection of the writings of Clemens on Tineina. The description was originally published in the Proc. Ent. Soc. of Phil., Vol. II. pp. 415-430, Mar., 1894:

*Hamadryas* N. gen.

"This imago, which I have placed in a new genus, appeared to me to be congeneric with a portion of the genus Gelechia. The hind wings are lanceolate. The sub-median and internal veins distinct. Sub-costal simole attenuated toward the base. The disk is closed and the nervules are given off from it. The median vein is three branched.

The fore-wings are lanceolate, with the inner margin dilated near the base of the wing. The sub-costal vein has four branches, the first arising near the middle of the wing, and the apical nervule furcate. The disk is closed, with the nervules given off from it. Median vein three-branched, the posterior branch arising midway between the space opposite the origins of the first and second sub-costa-marginal nervules. Sub-median furcate at the base. Head smooth, face and forehead broad, ocelli very small. Antennae rather thick, about one-half as long as the fore wings, denticulated beneath. Labial palpi moderately long, curved, rather slender, smooth, pointed; the middle joint slightly compressed, rather thicker and longer than the terminal joint, which is cylindrical. Maxillary palpi extremely short. Tongue clothed with scales at the base, and about as long as the anterior coxae.

H. bassettella. Fore-wings bright reddish-orange, sometimes tinted with yellowish orange, with a black spot at the base above the fold of the wing and a broad, black stripe showing bluish or greenish reflections along the inner margin, extending from the middle of the fold to the tip of the wing and occupying nearly one-half of the breadth of it. Along the costa, about the middle of it, is a shining black stripe, which becomes narrower as it approaches the apical third of the wing. Cilia blackish. Hind-wings shining, dark greenish-black. Head and thorax black. Antennae black. Labial palpi yellowish-orange."

"I am indebted to the kindness of Mr. H. F. Bassett of Waterbury, Conn., for a number of specimens of this interesting gall-miner. Mr. B. says the species is rather common in this neighborhood,—the larva feeds in a gall found on 'a species of oak which I call *Q. tinctoria.*' The galls are found on the smaller branches, three or four being aggregated, are globular, yellowish-brown, shining and hard. The species is dedicated to the discoverer who will doubtless work out its larval history."

From the above it will be seen that Mr. Clemens mistook the Coccid for a gall, a very natural mistake for a man not well acquainted with Hemiptera. His description applies perfectly to the Coccid.

Through the kindness of Dr. Howard of the Department of Agriculture at Washington, I am able to call attention to two more references to this interesting insect. Prof. Comstock (Rep. of U. S. Entomologist for 1879, p. 245) calls attention in 1879 to his having collected and bred the insect at Cedar Keys, Fla. He says: "This species was first described by Clemens under the name of *Hamadryas bassettella*, from specimens received from Mr. Bassett in Conn. The latter gentleman stated that he had bred it from a gall on oak, but subsequently Mr. Riley pointed out to him that his supposed gall was in reality a Coccid. The rearing of the same moth from what is evidently, if not the same, a closely allied species of Coccid from two such widely separated localities as Connecticut and Florida is a strong indication of the permanence of the carnivorous habit in this species."

In 1881 Mr. Riley refers very briefly to the insect as infesting the scales or bodies of *Kermes galliformis.*

Dr. Howard informs me that he collected this species in 1882 or 1883 in Kermes on an oak scrub in Ithaca, N. Y.

The fact that it has been found in four states as widely separated as Connecticut, New York, Florida, and Minnesota, is a pretty safe indication that the habit is firmly established.

## THE HIND BRAIN AND CRANIAL NERVES OF ACIPENSER.

BY J. B. JOHNSTON.

(From Anatomischer Anzeiger,—XIV. Band, Nr. 22 und 32, 1898.)

SUMMARY.

A. Facts.

1. The sensory Vth, VIIIth, and lateral line nerves enter common centers, namely, the Nucleus funiculi, tuberculum acusticum, and the granular layer of the cerebellum.

2. A large part of the Vth, VIIIth, and lateral line fibres go as arcuate fibres to the opposite side.

3. The Lobus trigemini of Goronowitsch is shown by its structure to be a part of the tuberculum acusticum.

4. There is continuity of structure between the acusticum and the granular layer of the cerebellum. In fact, the acusticum with the cerebellar crest corresponds in every detail with the cerebellum, and the one may be considered as the direct continuation of the other.

5. A large bundle of fibres (chiefly from the lateral line nerve?) runs from the tuberculum acusticum to the Nucleus funiculi and to a special Nucleus acustici spinalis.

6. The cells of the tuberculum acusticum send their dendrites to the base of the medulla.

7. There is a secondary tract from the acusticum which joins the spinal Vth.

8. The sensory VIIth, IXth, and Xth nerves (exclusive of lateral line and spinal Vth constituents) enter a common center, the Lobos vagi.

9. The secondary vagus tract divides into ascending and descending bundles. The ascending bundle ends in the Rindenknoten as described by others. The descending bundle extends into the cord.

10. Cells of the II type are found in the Lobus vagi, the acusticum, and in both layers of the cerebellum.

11. A remarkable cell of the II type found in the valvula has dendrites similar to those of the Purkinje cells and a very coarse neurite with peculiar club-like thickenings.

12. Meynert's bundles have two sets of fibres, one of which after decussating ends in a nucleus dorsal to the ansiform commissure and bordering on the central cavity at the posterior end of the base of the mid-brain. The other, composed of fine fibres, probably ends, after partial decussation, in the granular layer of the cerebellum.

13. The Corpus interpedunculare is probably a nucleus of secondary importance in connection with the bundles of Meynert.

B. Theoretical conclusions.

14. The structure of the sensory nerve centers in the medulla indicates that the cranial sensory nerves are arranged in two quite distinct complexes. One of these consists of the nerves supplying structures of ectodermal origin, the Vth, VIIIth, and lateral line nerves. The other consists of the nerves which supply structures of entodermal origin, the VIIth, IXth, and Xth nerves.

15. The sensory Vth, VIIIth, and lateral line nerves alone are homologous with the sensory roots of the spinal nerves.

16. The tuberculum acusticum and the cerebellum are the representatives in the hind brain of the dorsal horns of the cord.

17. There is in Acipenser a spinal VIIIth tract which is probably homologous with that in man.

18. The sensory VIIth, IXth, and Xth nerves are not homologous with any nerves in the trunk region.

19. The Lobus vagi has no homologue, or only a rudimentary homologue, in the spinal cord of the adult.

20. The sensory roots of the cranial nerves can not be considered as serially homologous with (the dorsal roots of) the spinal nerves in determining the segmentation of the brain or head. The motor roots alone are directly comparable to (the ventral roots of) the spinal nerves.

21. The peculiar character of the Purkinje cell dendrites seems to be due to their physiological relation with the very fine fibres of the molecular layer of the cerebellum.

# A CONTRIBUTION TO THE KNOWLEDGE OF THE FLORA OF TUSCOLA COUNTY.

BY CHARLES A. DAVIS, ALMA.

(Read before the Academy April 1, 1898.)

[Abstract.]

On the so called "Prairies" of the bottom lands near the shore of Saginaw Bay from the region of Bay Port southwestward, was found a group of plants, a considerable number of which have not been previously noted from the central or eastern parts of the state, and one plant was found which was heretofore only known from the single station on the southern border from which it ranges southwestward. The plants here found are characteristically those of the prairies of Illinois and adjoining states, and in Michigan they occupy a small area around the lower end of Lake Michigan. The soil conditions are such as are frequently found along shores of large bodies of water where deposition is taking place, i. e., sandy strips alternating with rich vegetable deposit or muck. It is probable that local climatic conditions due especially to the presence of Saginaw bay in the near vicinity are more directly responsible than favorable soil conditions for the presence of this colony of southern and southwestern plants in this place. If this is so, and is capable of proof, the region should be a very profitable one for the introduction of special crops which cannot be grown in less favorable localities so far north, as it is a well known principle of agricultural economics that the farther from the center of the greatest production of a given crop, that crop can be raised, the better price it will bring. No stations for the plants found, intermediate between those in the southern part of the state and this locality, are known. The most important plants found were Asclepias purpurascens L., A. Sullivantii Englm., Acerates floridana (Lam.) A. S. Hitch., Cratægus Crusgalli L., Cacalia tuberosa Nutt., Ludwigia polycarpa Short & Peter, Lythrum alatum Pursh, Lacinaria spicata (L.), Kuntze, and Silphium terebinthaceum Jacq.

This paper was published in full in the Botanical Gazette, Vol. XXV, No. 6, pp. 453-8, and the discussion of the entire flora of Tuscola county will appear in a forthcoming bulletin of the State Geological Survey on Natural Resources of Tuscola County.

# FIFTH ANNUAL MEETING, YPSILANTI.

MARCH 29, 30, 31, 1899.

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The fifth annual meeting of the Michigan Academy of Science was held at the State Normal School, Ypsilanti, March 29, 30 and 31, 1899.

In addition to the presentation of the twenty-eight papers, list of which will be found on a later page of this report, the following items of business were transacted: The minutes of the last meeting were read and approved.

The treasurer, Prof. W. H. Munson, submitted his report, showing the expenses of the Academy for the year to have been $57.50, the receipts $37.00, and the amount still in the treasury $107.78.

The secretary stated that in accordance with the directions of the Academy, one thousand copies of Dr. V. M. Spalding's presidental address, entitled "A Natural History Survey of Michigan" had been printed, and after distributing part of them to members and others, several hundred remained at the disposition of the Academy.

The following resident members were elected:

George Booth, Bay City; Frank Bradley, Alma; William A. Brush, Detroit; Benj. F. Bush, Grand Blanc; Albert B. Lyons, M. D., Detroit; Edith Ellen Pettee, Detroit; Jessie Phelps, Ypsilanti; Orlan B. Read, Hillsdale; Louis E. Warren, Hillsdale; Geo. A. Waterman, V. S., Agricultural College; Alfred H. White, Ann Arbor.

The secretary read a brief obituary notice of Arthur A. Crozier, one of the charter members of the Academy, who died January 28, 1899, at his home near Ann Arbor.

Walter B. Barrows, from the committee on bird protection, reported the preparation of a bill in the form of an amendment to the game laws of the State, aiming to secure the better protection of our useful and harmless wild birds. The proposed amendment is as follows:

Section 20 of Act 159 of the Public Acts of 1897 * * * is hereby amended to read as follows:

"No person shall at any time or in any manner whatever injure, kill or destroy, or attempt to injure, kill or destroy, any undomesticated bird of any kind, except game birds and water fowl at such times and in such places and manner as the Public Acts of this State shall permit: *Provided*, That it shall be lawful at any time to kill crows, blackbirds and English sparrows, or to destroy their nests or eggs."

It was proposed to have this bill introduced in the House and try to secure its passage. The report was approved and adopted.

A recommendation from the Council was adopted referring to a committee of five the question of the advisability of a section of the Academy to be known as the Section of Science Teachers or Section of Science Teaching, and instructing the committee to report at the next meeting. The members were: Prof. Jacob Reighard, Ann Arbor; Prof. Wm. H. Sherzer, Ypsilanti; Dr. W. J. Beal, Agricultural College; Prof. Chas. A. Davis, Alma; Mr. N. B. Sloan, Flint. To the same committee was referred the question of investigating the status of science teachers throughout the State, and in this matter they were requested to co-operate with a similar committee of the Michigan Schoolmasters' Club.

A resolution was introduced condemning the English sparrow bounty law and respectfully urging the legislature to repeal the act. Among the reasons urged for this action were the following:

1. Such bounty laws have been shown conclusively by the U. S. Department of Agriculture to be unscientific, expensive, ineffectual, and therefore injudicious and deplorable.

2. The results of the bounty law in Michigan, as investigated by the zoölogist of the Agricultural College, fully sustain the conclusions above, as published by the U. S. Department of Agriculture at Washington.

3. Aside from the useless expenditure of money, the law permits and actually accomplishes the destruction of very many valuable native birds.

4. Michigan stands almost alone among the states in thus persisting in an expensive and utterly futile attempt to exterminate this pest by the bounty system. The presence of this bounty law on our statute books, in the light of all the information at hand, is a serious reflection on the intelligence of our tax payers.

This resolution was adopted and referred to the committee on bird protection.

A committee on a natural history survey of the State was appointed as follows:

Bryant Walker, Detroit, chairman; Jacob Reighard, Ann Arbor; Chas. A. Davis, Alma; W. J. Beal, Agricultural College; Frederick G. Novy, Ann Arbor.

The following officers were elected for the ensuing year:

President—Jacob Reighard, Ph. B., Ann Arbor.

Vice Presidents—Section of Botany, Prof. C. F. Wheeler, Agricultural College; Section of Zoölogy, Bryant Walker, Detroit; Section of Sanitary Science, Cressy L. Wilbur, M. D., Lansing; Section of Agriculture, Prof. Clinton D. Smith, Agricultural College.

Treasurer, Prof. W. H. Munson, Hillsdale.

Secretary, Prof. Walter B. Barrows, Agricultural College.

## PAPERS PRESENTED AT THE FIFTH ANNUAL MEETING OF THE MICHIGAN ACADEMY OF SCIENCE, YPSILANTI, MARCH 29, 30 AND 31, 1899.

1. The Medical Inspection of Schools. Prof. Delos Fall, Albion College. Published in Teachers' Sanitary Bulletin (Lansing) Vol. 2, No. 3, March, 1899.

2. Bacteria of Every Day Life, (Stereopticon Lecture). Ernest B. Hoag, University of Wisconsin.

3. A Plea for Greater Attention to the Sciences, by the Church, the School, by Legislatures, and the people generally—Presidential Address. Dr. Henry B. Baker, Lansing. Printed in full in this report.

4. Variation of Latitude Observations at the Detroit Observatory. Prof. A. Hall, Jr., Ann Arbor. To be printed in the Astronomical Journal.
5. Beet Sugar Manufacture in Michigan (with lantern slides). Alfred H. White, Ann Arbor.
6. The Evolution of the Color-pattern of the Pigeon's Wing. Stereopticon Lecture. Prof. C. O. Whitman, University of Chicago.
7. Germination of *Brasenia peltata* Pursh. Prof. Chas. A. Davis, Alma.
8. Notes on *Utricularia resupinata* D. B. Green. Prof. Chas. A. Davis, Alma. Abstracts printed in this report.
9. A Study of our Native Elms and Poplars in Winter. Dr. W. J. Beal, Agricultural College.
10. The genus *Antennaria* in Michigan. Prof. C. F. Wheeler, Agricultural College.
11. Some Boreal Islands in Southern Michigan. Prof. C. F. Wheeler, Agricultural College.
12. Developmental History of Some Croton Seeds. Dr. J. O. Schlotterbeck, Ann Arbor. Abstract in this report.
13. The Effects of Mechanical Shock on the Growth of Plants. Dr. J. B. Pollock, Ann Arbor.
14. Plankton Flora of Lake Erie. Dr. Julia W. Snow, Ann Arbor.
15. Origin of Cell-wall Substance in Cell Division. H. G. Timberlake.
16. Rheotropism of Roots. Dr. F. C. Newcombe, Ann Arbor.
17. Terrestrial Shell-bearing Mollusca of Michigan. Bryant Walker, Detroit. Printed by the author. Detroit, 1899.
18. Trees as Dwelling-places for Animals. Dr. W. J. Beal, Agricultural College. Printed in present report.
19. A Jumping Gall. Rufus H. Pettit, Agricultural College. Mich. State Expt. Station. Bulletin 175, pp. 367-368 (Fig. 20).
20. Is the Nucleus the Sole Bearer of the Hereditary Qualities? Dr. Frank R. Lillie, Ann Arbor. Published in substance in "Adaptation in Cleavage," Woods Holl Biological Lectures, 1898, pp. 43-66.
21. Some Notes on the Breeding Habits of *Amia*. Jacob Reighard, Ann Arbor. Abstract in present report.
22. The Development of the Adhesive Organ of *Amia*. Jessie Phelps, Ypsilanti. Abstract in this report.
23. Restriction of Consumption. Dr. Henry B. Baker, Secretary State Board of Health, Lansing.
24. Comparative Statistics of Weather and Mortality in Michigan. Cressy L. Wilbur, M. D., Lansing. Printed in full in this report.
25. Some Methods and Results in Micro-photography. J. B. Johnston, Ann Arbor.
26. New Problems in Agriculture and New Phases of Old Ones. Prof. Clinton D. Smith, Agricultural College. Printed in full in this report.
27. Some Points in the Development of the Metanephros. Dr. J. Playfair McMurrich, Ann Arbor. Published under the title "A Case of Crossed Dystopia of the Kidney" in Journal of Anat. and Physiol., Vol. XXXII, 1898, pp. 652-664, 3 figs. in text.
28. The Existence of Nerve Fibers in the Cerebral Blood Vessels. Dr. Carl G. Huber, Ann Arbor.

## A PLEA FOR GREATER ATTENTION TO THE SCIENCES.

### BY THE CHURCHES, BY THE SCHOOLS, BY LEGISLATURES, AND BY THE PEOPLE GENERALLY.

(Presidential Address, to the Michigan Academy of Science, Ypsilanti, March 30, 1899.)

BY HENRY B. BAKER, A. M., M. D., PRESIDENT.

*Members of the Academy, Ladies and Gentlemen:*—As the minister of the gospel endeavors to propagate emotions and desires toward a forsaking of sins, and toward right conduct in every relation of man to man and of man to his Creator, so my present aim is to propagate emotions and desires toward a forsaking of imperfect methods of action, in the churches, in the schools, and in the halls of legislation; and to plead for a new life, more in harmony with divine laws.

If, as most of us believe, there is an infinite God, who is omnipotent, omnipresent, the creator of all things, and ruler of the universe, then not only all the laws which govern in the spiritual realms, but also all which govern in the material universe, are Divine laws; disobedience of which incurs penalties, knowledge of which will enable us to act in harmony therewith, and complete, exact knowledge would give mankind almost infinite control over our surroundings.

I plead for an extension of the emotions and desires of mankind so as to include a desire for right relations not only to our brethren and to the Creator of the universe, but also to every created thing with which man comes into relation.

### THE CHURCHES.

Let us grant that the main function of the church has been to stimulate emotion toward right conduct: what does that avail if ignorance of what conduct is right continues to prevail? The contrite heart, the earnest prayer to be saved from sin, ought to lead to a knowledge of *how* to be saved from sin; because if it does not lead to that knowledge, sin is yet likely to follow. It has been customary for mankind to plead innocence of sin when the sin has been involuntary and without knowledge; but it must be apparent to every thoughtful person that, with the laws of God as with the laws of man, every person is supposed to know the laws, and to obey them or suffer the penalities; and the penalties are much more certain to follow violations of the laws of the Creator than violations of the laws of man. Under all ordinary conditions, if a person puts a finger in the fire it is burned. All such common laws of the Creator are easily learned, but common business honesty is not easily learned except in the school of actual business life, or by special training in social science.

Under the present complex conditions of labor and society, the proper relations of man to man can be learned only by hard study, under the leadership of masters in social science. We have ministers of the ancient scriptures; we need also ministers of the recent writings concerning man's complex relations to his fellowmen. In order to fit us for right living, in all our various relations, the training must not stop with the stimulation of the emotions toward right conduct; it must extend to the settlement of questions of what actions are right, and what actions are wrong. In order to be most useful to humanity, the training should extend still further, and show *why* certain actions are wrong and why certain actions are right: We ought to have science, and also philosophy. To my mind such training is religious training; and it ought to be entered upon by the churches. This knowledge, of good and evil, of right and wrong, is needed with reference to man's proper relations to, and actions toward every class of persons, male and female, rich and poor, healthy or sick, maimed or defective, capitalistic classes and laboring classes, and under all ordinary combinations of circumstances.

The labor question, the questions of trusts, of taxation, of inter-state and international trade and commerce, of the spreading of devastating plague, influenza and fevers; these are all questions of right conduct of individuals and of peoples, to make possible right action in relation to which every person who influences their control should have the guidance of science, that is to say, of exact knowledge systematically organized.

How easy it would be to give the inhabitants of this world, or at least to all Christendom, a powerful impetus in the direction I have indicated! Much of the machinery is already planned and prepared. Think of the immense educational value of the present Sunday school system, if only its teachings could be extended so as to include the latest and best revelations of the divine laws which govern the universe!

There is no religious or other training which so broadens and deepens our conceptions of the infinite Creator as do the studies of the sciences, which convey exact knowledge of the exceedingly numerous, wonderful facts found in every direction which scientific research follows, throughout the universe, material and intellectual.

The Sunday school work has been less useful than the pulpit preaching, for stimulating and propagating emotions toward right actions; although its system of work has been wonderfully evolved, its teaching is still primitive. It lacks God's later revelations to man, as chronicled by Sir Isaac Newton, by Faraday, Helmholtz, Darwin, Tyndall and other earnest and successful seekers after the eternal truths.

Unless there can be a modification of the Sunday school literature, so as to utilize the best work in all the sciences (and this may be a very difficult undertaking) I hope you will join with me in pleading for a copying of the methods of the Sunday school literature and the adoption of Sunday school methods, to the end that it shall be possible to teach, at least Sunday afternoons, interesting and valuable practical results of the work of leading scientists in every branch of exact knowledge.

Why should not religious training, why should not the church regain the position of the writers of the bible, who set out to give rational views of man's relations to man, to God, and to all his creations, from the beginning, as given in the first chapter of Genesis?

Why not reconstruct our conceptions of the creation, according to the latest revelations?

Why not listen to the teachings of leaders of thought, and construct conceptions of the proper relations of employer to employee, and of employees to employer?

In short, why not rely upon the best knowledge obtainable, relative to all our surrounding conditions, bearing upon our present life and upon our destiny throughout eternity?

There was a time when one man could compass the entire range of such knowledge then possessed by humanity. Now that is impossible. Perhaps that is the reason why, for many years, the churches have been making such slight progress. It is claimed that the church membership is not keeping pace with the increase of population, that business men, artisans, men whose occupations teach them many of the laws of nature, do not join the churches. Their minds are engrossed with thoughts of the laws of sound, as taken advantage of in the telephone; of the laws of light, as revealed in the X rays phenomena; of the laws of electricity, as utilized in the electric light and the electric motor. These recent revelations are so real, so wonderful, so exceedingly useful in giving increased control over conditions tending so strongly to make life more complete and more comfortable, that it is coming to be more and more difficult to listen to sermons based upon views formed in the infancy of the human race, when language was meager, because ideas were fewer, when conceptions of the Creator had to be formed from the comparatively few evidences then possible, when therefore mental images of God necessarily had human attributes, which were pondered over and recorded, but which now, when used as texts, fail to supply satisfactory conceptions of the omnipotence, omnipresence, and universality of the Creator of infinite varieties of animals, plants, substances and forces, all apparently working in accordance with fixed laws. The human attributes of the Creator which in a past age had comparatively strong evidence of probability, are now very much less apparent to minds which have the evidence of nearly all of their senses to the materialistic phenomena of His laws of heat, light, electricity, and sound. To the modern scientist, God is less human, more infinite, than to the unlearned ancients.

### A NEW DEPARTURE SUGGESTED.

Is it not possible for the church to regain and multiply its mastery, by specializing its work along the lines of the physical and social sciences?

It being apparent that no one minister can master all the sciences, is it not practicable for the church not only to retain its present work, but to do what other kinds of workers have done—perfect its workers along different lines of effort? Why not retain the ancient theology for the forenoon service, and the forenoon Sunday school, and utilize at least a portion of the afternoon services for the modern theologies—in other words for the sciences?

Why not employ the best available talent in simplifying and popularizing the social and physical sciences, by means of Sunday afternoon lectures?

Why not bring these valuable lessons to the children, by means of Sunday afternoon schools modeled after the recent improved plans for Sunday schools, with their special literature systematically presented, as in the quarterlies and other literature used in the congregational and other Sunday schools?

THE SCHOOLS.—WHAT EDUCATION IS OF MOST WORTH—TO HUMANITY.

In his work on "Education," Herbert Spencer, if I remember correctly, answered his own question "What knowledge is of most worth?", with reference to the individual man. I propose to deal with this question, having in mind mainly the welfare of the entire human race; also, not simply extending the application of Mr. Spencer's conclusions, but attempting to evolve a principle,—that, as the Creator is infinitely greater and wiser than man, His laws and works are infinitely more profitably studied and mastered than are man's laws and works.

Before this audience it is not necessary to present arguments for the value of ordinary education, which prepares the young for their life work by supplying them with the means for accurate communication with their fellows, and for understanding the works of others; it is not necessary to present arguments for the value of strictly literary education, we all admit the immense value and utility of education along literary lines. I believe we do not all rightly appreciate education along scientific lines, other than in mathematics and in the scientific construction of language. Reading, writing, and arithmetic are indispensable as preparation for actual work, and a mastery of any branch of the world's literature is a source of power in certain fields of effort, such as teaching and lecturing; but a life work that is to add greatly to the progressive welfare of mankind must add to man's control over the conditions which surround us; and for such a life work, something more than the highest work and laws of man are essential; nothing short of the unchanging laws of the Creator are required for the highest progressive work of man. And those natural laws, laboriously worked out, constitute the fundamental principles of the sciences.

It took centuries to build up the science of astronomy, accurate measurements of time, the use of the compass, and accurate knowledge of the winds and waves, so as to enable man to cross the trackless oceans as he now does, to our great benefit and pleasure. One function of literature has been to hold fast what has been gained by science; but literature alone could never have built up the commerce of the world, nor have enabled man to span continents with railroads, harnessing the power of steam to carry immense loads across mountain ranges; literature alone could not enable man even to invent a steam engine.

The best uses of literature are—to rightly stimulate the emotions, and to disseminate, and preserve for future generations, scientific and other progress; but an equal or more important service to mankind is the revelation of knowledge new to man, to be disseminated and preserved. This is the work of science, in every possible direction, to search out and reveal the laws which an infinite Creator has ordained, and to which laws man must conform or suffer a miserable existence and a dreadful end.

A literary gem or an elegant oration fills the mind and soul with satisfaction and enthusiasm; but, may not the work of a plodding entomologist, who laboriously works out the life history of a parasite on a potato bug, yield results of more permanent utility to mankind?

A stirring poem stimulates emotions toward right living and great deeds; and a strong novel, like "Uncle Tom's Cabin," has great evolutionary force; yet discoveries due to progress in exact knowledge in nature's realm, as, for instance, the working out, by the immortal Jenner, of the nature of the dairymaid's disease—cowpox, the scientific establishment of vaccination, and the consequent gaining of power by man to absolutely prevent the most loathsome disease ever known, are worthy to outrank any such literary work ever done or likely to be done. For such work as advances the world's stock of useful knowledge, accurate observation of nature, systematic arrangement of facts, and, above all, the habit of scientific thinking—these are the essentials. To illustrate my idea of the habit of scientific thinking: Two men were talking on several topics. One who listened would soon notice that, whatever topic was broached, one of them uniformly soon used a literary quotation, once repeating something which a philosopher is alleged to have said some sixteen hundred years ago. His mind was stored with literature, his habit of thought was literary, he had in his mind no stock of facts or principles relative to the great forces or materials of nature, from which to draw and use in connection with whatever phenomenon was brought to his attention, his mind was not stored even with the literature of any of the physical or social sciences, consequently he was and is incapable of adding anything new to man's control over his surroundings, his knowledge stopped with grasping what men before him have done. Not having his mind stored with the laws of nature, and not having the habit of scientific thinking, his life could not add much to the welfare of the world, through material, moral, or social *progress*, however powerful and useful he might be in influencing emotions, toward self-mastery, goodness and greatness.

Of the two men, the other man was well known as one who has deeply studied certain sciences, and is believed to have contributed something of value to the world's stock of exact knowledge along one of the sciences. It was apparent that his habits of thought were upon scientific subjects, his references were not to the literature of the classics, rarely even to the literature of the sciences, but he referred to the universal law of gravitation, the doctrine of the indestructibility of matter, the law of the persistence of force, the correlation of the physical forces, that action and reaction are equal and opposite, and to the fact that heat, light, electricity, and sound, are modes of motion.

Is it not easy to see why it is impossible for the first of these two men to advance the world's knowledge of the materials and forces of nature, and why it is perfectly possible for the other one to do so?

You may notice that I am setting up a standard by which to judge of the values of educations, and ranking as of most value that education which enables man to add to the world's knowledge of the laws of nature and how to control and utilize the conditions which surround us, for the benefit of mankind.

I submit that this is a higher standard than any which looks merely to the selfish interests of the pupil. But is it not true that most of us would, selfishly or unselfishly, choose to follow in the footsteps of Sir Isaac Newton, of Faraday, Morse, Tyndall, Edison, Alexander Graham Bell, and the others, who have advanced the cause of science, and brought to mankind the benefits and the luxuries of the telegraph, the telephone, the electric light, the electric motor, the X-ray, not forgetting the earlier modes of control of fire by the invention of the lucifer match; of the control of water, by means of the turbine wheel; of the air, by means of the windmill; of fire and water as steam, by means of the boiler and steam engine?

Is it not a fact, that all of the material progress in this world has come about through the advancements of the sciences? I know it is claimed that the arts precede the sciences, but progress has been made not so much by studying the works of man as by studying the works of the Creator. Great inventions, so many of which are termed "discoveries," are not made by persons ignorant of the Creator's laws. To those who intelligently interrogate nature, these great revelations are made. They are not made to minds stored only with the gems and masterpieces of classic literature. They are revealed to those whose habits of thought are in consonance with science, whose thoughts are concerning the facts and general principles of nature. In recent years great discoveries have followed each other with a rapidity before unprecedented, because never before in the world's history have there been so many men skilled in the sciences, and also working close to nature. And it is worthy of notice that, as a rule, the great inventions and discoveries have been made not by the teachers, who necessarily have been most skilled in the general facts in the literature of their several sciences, but by those still nearer to nature, those who have been studying nature in one particular line even more closely than those occupied with the literature of the sciences. Thus they have added to the world's useful knowledge, and to its literature on the sciences, what will in time serve as new departures for still more important inventions, discoveries, revelations.

What an impetus would be given toward progress in inventions, if half of those who now are trained in strictly literary studies until they are nearly thirty years of age could have the last ten years of that time devoted to studies of the sciences, first in technological schools, and later in actual contact with those parts of the world's work to which the sciences of chemistry, physics, electricity, metallurgy, etc., are so closely related, training not so much to make expert workmen, but with a special view to future inventions and discoveries!

If I am right in my belief that the education of most value *to humanity*, is that which enables us to add to the world's knowledge of the laws of nature and to knowledge of how to control and utilize the physical and social conditions which surround us, for the benefit and pleasure of mankind, it follows that this is the sort of education which the people,—the State should foster and insist upon.

And inasmuch as whatever benefits the race, generally benefits the individuals, whose interests are generally parallel to those of the race, therefore, is not the sort of education which is of most value to the individual—that which enables him to add to man's control over existing conditions?

If I am right in my belief that it is not knowledge of literature, history, grammar or geography, that gives man greatest power to add to the world's knowledge of the laws of nature, and greatest power to control and utilize surrounding conditions, then it follows that the interests of humanity demand—that more attention than is given to those studies just mentioned should be given to gaining a knowledge of the facts, laws and general principles which we know as the sciences.

If I am right in my belief that the habits of thought of students of general literature are antagonistic to the accomplishment of inventions and discoveries along the lines of scientific progress, then not all the people should have that training.

If knowledge of some of the laws of nature supplies the best preparation for gaining knowledge of other laws not yet revealed, then, for the purpose of progress, the best possible educational training is in the sciences, and, as a rule, if progress of the race is sought, no more time should be devoted to other studies than is sufficient to prepare the pupil for studies in the sciences.

Even if we grant that, in teaching "The principle is to train 'for power,' to use President Elliot's phrase, and not primarily for information,"* is it not of far greater importance to humanity to train "for power" over the physical forces, over the material universe and over our social surroundings, than it is for power over the mere literary or other works of man?

However, I am not willing to throw away the literary works of man;—what I plead for is—that this be saved to the race by the few, while a much larger proportion of our young people than heretofore shall be trained in directions of far greater utility to mankind, namely in the sciences.

LEGISLATURES.

I have expressed the view that, for the general welfare through material progress, the sort of schools which the people generally should most liberally support are those wherein the sciences are taught; because about all progress, in man's control over his surroundings is due to progress in exact knowledge, that is, to progress in some science. Support for such schools can, as a rule, be supplied only through legislative action. Thus far State legislatures generally have not taken much action in this direction; but the United States congress has shown great wisdom in fostering education in that science which has to do with supplying the food for mankind; I refer to the science of agriculture. In 1857 Hon. Justin S. Morrill introduced in congress a bill, and in 1862 congress made grants of land to enable the several States to establish agricultural colleges. Some of the State legislatures were wise enough to act in that direction. We ought to be proud of Michigan that, before any action by congress, the State constitution, framed in 1850, provided for a school "for instruction in agriculture and the natural sciences connected therewith." We ought to be proud of Michigan legislatures for taking, as early as 1855, and for maintaining since that time, most efficient measures for the success of that college. Congress has established, at Washington, a national department of agriculture, an important branch of the government, and it is a great national college of agricultural science, which has as pupils a large portion of the people of this country.

*"The Teaching of Physiology in Medical Schools," by W. T. Porter, M. D., Associate Professor of Physiology in Harvard.

The prosperity and growth of this country has been marvelous; a very great portion of that growth and prosperity is due to the agricultural work done; and the character of that work has been, and is being, greatly improved through the scientific training, in the State agricultural colleges, of a few who serve as leaders, and through the scientific work of the United States Department of Agriculture. Congress has recognized the fact that progress in this direction cannot be made except through scientific study and experimental research work. Accordingly it has appropriated money to establish, in the several States, agricultural experiment stations. These scientific experiment stations are doing a grand work for the progress of those sciences on which is based the art which feeds the civilized world. Through progress in the agricultural sciences, agricultural products have been increased and cheapened; and must continue to be cheapened, so that a smaller and still smaller proportion of the people are to be able to supply mankind with food, and a much larger proportion of our people are to be able to engage in other pursuits. It ought to result, also, in much less hours of physical labor to agriculturists, and to all classes of people.

What I plead for is a continuance of the congressional and legislative fostering of the agricultural sciences, but more especially the application of the same principles of action to the other sciences. Let us have the science of mechanics, and the other sciences which bear upon the production of clothing, so fostered by governmental experiment stations and technological schools, that a much smaller proportion of our people shall be required to labor, and during less hours, in those industries which supply our clothing. For several years the artificial production of silk has been struggling toward perfection. If the governments would maintain experiment stations for this purpose, possibly all of us might soon dress in silks, and at much less cost than now in cotton?

Recently much of the world's progress has been through the sciences of electricity, light, and sound. As an illustration of the utility of the telephone: "There are over one thousand telephone instruments used by the United States Life Saving Service. A notable instance of the benefit of it was the work achieved near Cape Henelopen, during the most destructive storm that ever visited the coast. The crews of three stations were brought together within two hours, and rescued twenty-two stranded vessels and one hundred and ninety-four persons."

There is no reason to suppose that all the secrets of nature have been revealed to us relative to the transmission of light and sound. Through the wonderful properties of selenium we have been on the point of being able to transmit to a distance, by wire, views of objects, even photographic likenessess and views of scenes. Governments might well maintain experiment stations for the advancement of knowledge in the sciences of electricity, light, and sound.

The United States government has appropriated money to aid investigations into aerial navigation; and even to looking for the north pole; both of which objects may be worth much more than the cost, especially as, by reason of the comparatively recent control over electricity, the working out of the principle of the aeroplane, the cheapening of the manufacture of aluminum by means of the electric furnace, and the new methods of liquifying air, successful aerial navigation seems now to be among the possibilities of the near future; but the point I wish to make here is that both the general government and the several States might well establish and maintain experiment stations for the advancement of exact knowledge on those sciences with which the every-day life of all the people is so closely concerned, as, for instance, the sciences relating to heat, light, electricity, sound, and locomotion.

As regards locomotion, the crude modes by means of the more or less perfect control of animals, is fast giving place to the bicycle, and to electrical and other automobile methods, connected with which there are many lines of investigation which might well be fostered by governments.

## THE SOCIAL SCIENCES.

My plea for greater attention to the sciences is not restricted to the physical sciences. When great numbers of strong men are unemployed and their families suffer thereby, great wrongs are apparent; and governments are not subserving the highest interests of the people unless they take prompt and effective measures to search out the causes, and to place them before the people. Possibly "experiment stations" are not adequate for the elucidation of such questions, although they may be for some of them, but if the social sciences shall be carefully studied in the churches, in the schools, in legislatures, and in every domain of human activity, can there be a doubt that the welfare of every class of people will be greatly enhanced?

The inaugaration of systematic studies of these sciences is an imperative duty of the churches, of the schools, of the legislatures, and of all of us.

## THE SANITARY SCIENCES.

One of the most important groups of sciences, thus far almost entirely neglected by governments, so far as relates to effort for the advancement of the sciences, is that group which collectively is known as sanitary science. A few of the States have made small appropriations. Scarcely anything has been done directly by the United States government, although indirectly, by fostering the Bureau of Animal Industry, much has been done for the welfare of the human race. The agricultural experiment stations, for which the United States makes annual appropriations for every State, are, to a great extent, for the benefit of all the people, but primarily they are for the benefit of a class only—the agriculturalists; while progress in sanitary science is primarily and finally for the benefit of every person, therefore, why should not congress appropriate money to establish, in every State, sanitary science experiment stations? A bill was prepared for this, which congress was asked to pass, but did not. I believe that this is a proposition on which the people themselves would do well to act, by petitioning congress to take such action, and the State legislature to foster a sanitary science experiment station as it now fosters the one for the agricultural sciences.

The State of Michigan maintains one school for the teaching of science, the State Mining School at Houghton; and several branches of science are taught at the State Agricultural College, at the University, and at this State Normal College; but, although there have been small appropriations for the geological survey, the State Board of Health, and for the Fish Commission, which have been used in part for such purposes, so far as I know, this State does not directly appropriate money for the advancement of any science by experimental work.

I claim that, in the interests of progress for the benefit of the people generally, the State ought to appropriate money for the advancement not alone of the agricultural and mining sciences, but of all the sciences. Especially ought the State Laboratory of Hygiene, at the University, to have a liberal appropriation for the advancement of several of the sanitary sciences.

The State publishes the annual reports of the State Agricultural Society, and of the State Horticultural Society. It ought certainly to publish the reports of this Michigan Academy of Science, which is not limited as the other societies mentioned are, to a special class of citizens, but may embrace every science, and subserve the interests of every class of citizens.

### THE PEOPLE GENERALLY.

The people generally can exert a powerful influence for the progress of science, by petitioning congress and the State legislatures to inaugurate and maintain schools of science, professorships of the sciences, and scientific experiment stations.

Much can be done by selecting for ordinary conversations scientific topics, instead of the usual topics which are of much less importance.

Much good can be done by the establishment and maintenance of local scientific clubs and associations.

Every intelligent person ought to become especially interested in at least one science; and not only read, from time to time, standard books on that subject, and take and read a periodical devoted to that science, but should labor to contribute facts, and if possible envolve a general principle to add to the stock of the world's exact knowledge. Only in some such way can we "Make our lives sublime, and departing, leave behind us footprints on the sands of time."

### GENERAL CONSIDERATIONS OF THE SUBJECT.

I believe that neither the people generally nor even those among us who are engaged in scientific pursuits, realize the extent of our indebtedness to science. Nor do we realize that we would still be painfully groping our way through an imperfect and uncomfortable existence were it not for progress in the several sciences, which progress was, for many years, hindered by the churches, its place in the schools opposed by lead ing educators, not aided by legislatures, and ridiculed by the common people.

We have not time for the enumeration of the items of our daily use for which we are indebted to science, but let me briefly mention a few of the notable examples of comparatively recent achievements of science:

MASTERY OVER THE FORCES OF NATURE.

Speaking now somewhat figuratively:

Science has *tamed the lightning*, and made it convey our messages far over the land, and under the sea, so that our thoughts may almost instantly be sent around the world, by the telegraph. Great famines are no longer excusable, because the want of one country can be made known to any other country.

Science has *educated the lighnting*, and taught it to carry voices, and speak our words in distant places, by the telephone.

Science has "*harnessed the lightning*," and made it pull loaded cars which until recently were drawn by horses and mules.

Science has *utilized the lightning*, to light our streets and houses, to heat furnaces, to melt refractory substances, also to aid our vision so that, by means of the X ray, interiors of bodies may be seen and photographed, fractured bones may be seen and replaced, and surgical relief be given.

Science has made it possible, by the storage battery, to *store up the lightning*, and liberate it as needed for various useful purposes.

Science has made it possible, by the phonograph, to *store up the tones of the human voice*, and to so liberate them that they shall be reproduced, from time to time, and utilized for the ordering of business affairs; also to store up the tones of musical instruments and voices, and liberate them at will.

Science has made it possible to harness Niagara Falls, and to use its energy, and transmit it to distant places for use. And the application of this principle is world-wide.

MASTERY OVER THE SUBSTANCES OF NATURE.

Science has made it possible to make the air about us into a liquid which promises to be of wonderful utility, and perhaps to do a considerable part of the world's work for humanity.

MASTERY OVER THE DISEASES OF MAN.

In our own day, a science, bacteriology, dealing with the excessively small things of this world, has revealed to man knowledge which gives him power to restrict and prevent the disease which destroys more lives than does any other; which as a rule destroys man in the prime of life; in our own State annually destroying three thousand of the best among us, and involving an annual loss of millions of dollars, beside the unspeakable anguish to thousands of those of us who remain.

Now, thanks to the scientific work of many, to Robert Koch more than to any other, there has been revealed knowledge which is able to make us "wise unto salvation" from that "Great White Plague"—consumption which, up to this generation, has been the scourge and destroyer of the flower of the human race, but which now bids fair to disappear.

Let us not dwell on the many remaining sufferings of mankind, due to man's neglect to seek the truth, and govern his actions thereby. The world has been improving as a place of comfortable existence, but it is still far from perfect. Much remains to be improved. Man is still far below the infinite, but he approaches the infinite in proportion as he searches out and obeys the laws which govern the universe.

My plea is for a higher standard—a better criterion—toward which and by which to aim religious, educational, legislative, and all other human effort,—a plea for the forsaking of much of the less valuable work of mere *men*, in the dim past, and a vigorous entry upon the works of the Divine Creator Himself:

> "Build thee more stately mansions, O my soul,
> As the swift seasons roll!
> Leave thy low-vaulted past!"

My plea is for humanity, not for selfishness; but if mankind as a whole advances, surely as a rule, the individuals advance. Philanthropy is the highest and noblest selfishness,—it is the most certain to secure what no other form of selfishness can secure—the greatest good to the greatest number of persons.

In closing, permit me to summarize, and to exhort you that

THE ADVANCEMENT OF SCIENCE IS DIVINE IMMORTALIZING PHILANTHROPY.

> Take up man's heaviest burdens, O my friends,
> And trace them to their causes, speed their ends!
>
> All science search, God's changeless truths reveal,
> Add useful knowledge for the common weal!
>
> Approaching infinite philanthropy,
> You thus approach to immortality.

## NOTES ON THE GERMINATION OF BRASENIA PELTATA Pursh.

BY CHARLES A. DAVIS, ALMA.

[Abstract.]

The freshly gathered seeds of this species were placed in water in the fall and kept through the winter, well into the following summer, never being allowed to become dry. One seed germinated in December, a few before spring, but the greater number of those which germinated delayed until the following summer, in July. Many of the seeds failed entirely to germinate; a few developed distorted monsters and a considerable number reached a stage where they possessed several leaves.

The first external sign of germination was the pushing out a rounded plug or stopper of the hard seed-coat from the hilum end of the oval seed. Through the opening thus made the hypocotyl and the very short petioles of the cotyledons were pushed, the cotyledons themselves not emerging. The hypocotyl was a very short, disk-shaped organ, from the lower end of which a filiform unbranched primary root grew. The hypocotyl did not elongate after it had emerged, the stem and secondary roots, also unbranched, developed by the expansion of the plumule, the roots appearing in the axils of the leaves. The first leaf, as is generally the case in Nymphaeaceae, was bladeless, elongated and filiform. The second leaf was usually lanceolate with a long petiole. The third leaf was sometimes perfoliate near the margin, but notched at the base, and sometimes the petiole was attached as usual, and the base was heart-shaped. The fourth leaf was always perfoliate, as were the succeeding ones, the insertion of the petiole approaching nearer the center of the oval leaf in each successive form, but in none of the seedlings studied did the type form of a perfectly elliptical leaf with the petiole in the center, appear.

## NOTES ON UTRICULARIA RESUPINATA B. D. Greene.

BY CHARLES A. DAVIS, ALMA.

[Abstract.]

This plant grows in the sand along shallow margins of lakes. It has been found in Pine Lake, Ingham county; Woodward Lake, Ionia county; Bass Lake, Montcalm county, and one or two other localities in the state. It is often overlooked because of its resemblance to small grass-like submerged plants, only the tips of the linear leaves appearing above the sand. The characteristic bladders are attached to the bases of the leaves, and to special branches of the stem. The leaves in floating specimens are in whorls of three. Two of these are geotropic, and one heliotropic, all bear one or more bladders. The geotropic leaves are rather smaller than the others. The growing tip of the stem is also slightly geotropic, but apparently not decidedly so. In plants growing under natural conditions the stem grows a short distance below the surface of the sand, the base of the upright leaf being buried perhaps an inch. The two geotropic leaves then spread out widely in the sand and sometimes bear several bladders. There are also special branches at irregular intervals which seem to bear only bladders without any true leaves. These seem more numerous in the vicinity of the base of the flower stalk. There are also fine branches of the stem which seem to be roots, but it seems probable that they are bladder bearing branches from which the bladders had been broken in the process of collecting. No roots appeared on floating stems kept for two years in an aquarium. The stems survive the winter buried in the sand.

## TREES AS DWELLING PLACES FOR ANIMALS.

BY W. J. BEAL.

The rodents and the woodpeckers seem to be especially adapted to living in trees, as the former have stout chisel teeth and the latter a beak for pecking holes.

The chief point I had in mind, when I decided to speak on this topic was to show how these holes originated and how they were kept in good condition suitable for dwellings. If you were to hunt about in the forests, you would be surprised to discover the great number of kinds of injuries that trees are subject to. The holes in trees were not purposely left there by the trees to serve as homes for animals, but rather the holes came there by some accident to the tree. In the forests, trees crowd each other, as they grow larger and taller, the limbs shading each other, till for want of light, some of them die, or the wind or heavy sleet or the falling of a neighboring tree breaks off all or a considerable portion of a limb. When the trees are sound and thrifty these damaged spots usually grow over or close up the wound, but when the tree has nearly completed its height and has sent forth numerous large limbs and has gone far past its prime, these wounds heal slowly or not at all. The dead limb, or the spot where it broke off, slants upward, permitting water and decay to enter, till finally, a hole takes the place of the dead branch, and within the tree a large cavity is often formed. Sometimes two or three limbs near each other die and there may after a while appear two or three holes. Many of these holes, the tree attempts to enclose, year after year, and would finally succeed did not some keen rodent need it for a dwelling. As the hole grows dangerously small, he gnaws off the new growth, compelling the tree to keep "open doors." Squirrels could use cavities entered through holes large enough for coons or hedgehogs, but they usually seek places entered through holes just about large enough for the largest one of the family. In this way, they are not molested by their larger enemies. Mice of the woods could use holes large enough for squirrels, but they usually seek lodgings of very small size. When once within hawks and owls can do them no harm.

All of these animals are shy of one another and besides, their habits are not all alike. The coon, flying squirrel and mouse are stirring about by night and remain at home asleep by day, while the gray squirrel and red squirrel sleep nights and are busy at work and play by day.

Coons store up food in the form of fat, and during cold winter curl up and remain dormant for weeks together, while some squirrels lay in a good store of nuts for use, when the ground is covered with snow.

[This paper was well illustrated by numerous blocks or sections, showing the origin and formation and maintenance of homes for animals.]

## THE BREEDING HABITS OF THE DOG-FISH, AMIA CALVA.

BY JACOB REIGHARD, ANN ARBOR.

[Abstract.]

The paper, of which this is an abstract, is a contribution towards the determination of certain disputed points of fact concerning the breeding habits of the dog-fish. By way of preface there is given a brief statement of those facts about which there is general agreement.

In late April and early May the dog-fish seek the shallower waters of our lakes and rivers and there prepare nests in which they deposit their eggs. These nests are circular areas, from which all leaves and stems of water plants have been removed. The bottom of the nest, which is concave, is formed of the fibrous roots of water plants, less often in the absence of these, of gravel, or of the water soaked leaves

of the cat-tail. Its sides are usually of growing water-plants. Nests built, as often happens, under logs, stumps, or bushes, are apt to be irregular in form and to have no vegetation at the sides. The bottoms of the nests are covered by from one to two feet of water and are closely strewn with the adhesive eggs.

The male fish remains on the nest or in the neighborhood and guards it until the young fish are hatched.

The newly hatched larvae remain for some days attached to the bottom of the nest by means of a peculiar adhesive organ situated at the end of the snout. After a time they leave the nest in company with the male and for some time they remain together in a dense swarm which is attended and protected by the male. When the fish have grown larger the swarm disperses.

Neglecting the earlier observations of Dr. Estes,[1] the foregoing statements are taken from three published papers. Those of Fulleborn,[2] of Dean,[3] and of Whitman and Eycleshymer,[4] and are corroborated by my own observations extending over eight years.

The points upon which these writers are not in agreement are indicated under the first five headings below, while under the sixth head I have given some observations on the act of spawning. My observations were nearly all made during the springs of 1898 and 1899, in a small bay of the Huron river—a bay which measures about 230 by 30 yards. In this area 21 nests were located in 1897 and the same number in 1898.

1. *Are the nests made at the time of spawning or earlier?*

Whitman and Eycleshymer have made no observations of their own, but quote with approval a letter of Ayres, who says: "The nest is not a premeditated structure, but merely the result of the movements of the fish in and about the place selected for spawning, during the period of sexual excitement." Ayers does not quote observations in support of this view. Fulleborn and Dean have found nests prepared in advance of spawning and Dean speaks of nests which were occupied by fish for a number of days before the eggs were deposited.

Of the twenty-one nests observed by me in 1898, thirteen are known to have been built *in advance of the deposit of the eggs*. Eggs were laid in eight of these nests, while five were abandoned without eggs having been laid in them. The interval between the building of the nest and the laying of the eggs varied from fifteen hours to six days, the latter period an unusually long one.

2. *Are the nests made by the male, by the female or by both?*

The male is distinguishable from the female by a conspicuous orange-bordered black spot on the tail and by green fins. It is possible to distinguish the two at a distance of ten feet.

Fulleborn observed nests occupied by male fish before spawning, in-

[1]Estes, Dr.: In Halleck's. The Sportsman's Gazette.

[2]Fulleborn, F.: Bericht ueber eine zur Untersuchung von Amia, Lepidosteus und Necturus unternommene Reise nach Nord-America. Sitzungsberichte den Aakad. d. Wiss zu Berlin. XL, pp. 1057-1070. Oct. 25, 1894.

[3]Dean, Bashford: The early development of Amia. Quart. Jour. Micr. Sci. XXXVIII. February, 1896.

[4]Whitman & Eycleshymer: The Egg of Amia and its Cleavage. Jour. Morphology. Vol. XII, No. 2, 1896.

dicating the males as the architects. Dean and Ayers (as quoted by Whitman and Eycleshymer) believe the nests to be made at the spawning time or just before, by the circling of the fish.

I have collected two sorts of evidence bearing on this point. First. By stretching a fyke net across the mouth of the bay in which the nests are made, sometime in advance of spawning, I have been able to determine how many and what fish seek the spawning ground first. During seven days (April 14th to 20th) forty-four fish were taken, of which thirty-nine were males. In the thirteen nests which were observed to be built in advance of spawning, eleven were seen to be occupied by male fish and no females were seen about them until the eggs were laid. The males had evidently built the nests and were awaiting the females. In eight cases the females arrived and eggs were laid in the nests. Additional evidence on this point is given under the next head.

3. *What is the method of making the nests?*

I have examined no less than a hundred nests to see whether there was any evidence of this being produced by a circling of the fish at the time of spawning, but have never detected any such evidence. The surrounding plants are not pressed aside nor arranged in any way like the materials of a bird's nest. The nests have the appearance of having been formed merely by the removal of the water-plants or other materials so as to form a concavity, the bottom of which is formed usually of fibrous roots.

The nests are frequently under logs or stumps where a circling of the fish would be difficult of execution.

Besides this negative evidence, we have several times, while sitting quietly watching, seen the swirl of a fish's tail among the water-plants at the surface and have been able to determine that the fish was a male. The fish was in such cases working at the bottom with his head, and freshly cut young shoots of water-plants were often seen floating over such places. In several cases I was able to follow the history of such places continuously and to make out that they were afterward occupied by nests. The male then appears to make the nest by biting and tearing away the aquatic plants.

4. *How near are the nests together?*

This depends on the nature of the bottom. Where the locality is favorable, as about a fallen log, nests may be built within a few feet of one another. With a wide area of bottom suitable for nest building at all points nests are more scattered. I found the average distance of twenty-one nests to be thirty-five feet. Dean says that "as many as half a dozen nests were found to occur within the space of a few square yards." Whitman and Eycleshymer remark, "this needs confirmation." They have found the nests, "never more than four or five in a single bay and usually rods apart." Both statements may be true, the frequency of nests depending mainly on the area of suitable bottom as compared to the number of spawning fish.

5. *What is the length of time occupied in spawning?*

Dean, on what evidence is not clear, believes that the "spawning occupies considerable time" and conjectures that in some cases as many as twelve hours are thus consumed. "In this" remark Whitman and Eycleshymer "he is probably much mistaken." Again they say: "That the average period of deposition is brief, can hardly be doubted, since in most cases the eggs of a nest are found in the same, or nearly the same, stage of development."

In several nests I have found eggs in cleavage stages varying from two to sixteen cells. According to the table given by Whitman and Eycleshymer, to show the time occupied in development, there is an interval of about three hours between the *two cell* and the *sixteen cell* stage. In these cases then the deposition of eggs must have occupied this period at least. Additional evidence is given under the *sixth head* below.

As development proceeds differences of a few hours in the age of the eggs in a nest are not at all noticeable—so that all the eggs from a nest appear to be in the same stage. In the cleavage stage, on the other hand, differences in age may be measured with great accuracy.

I have twice found nests which contained two sets of eggs of widely different stages. In one of the cases my record showed that the nest had been spawned in and then abandoned, to be subsequently spawned in by a second fish.

6. *The method of spawning.*

Having built his nest the male guards it and I have several times seen males leave their nests in order to drive other males from the neighborhood. On such occasions the males frequently fight fiercely, so that one often finds them at the spawning season with portions of the fins bitten away or strips of the skin torn from the sides. The male thus holds the nest until a female arrives, when the spawning begins. This may occur at any time of day or night. The females lies in the nest and the male circles about her head, frequently stopping to bite her gently on the snout or sides. These maneuvers continue for ten to fifteen minutes. The male then places himself by the side of the female and there is a violent agitation of the fins of both, during which the eggs and milt are emitted. This continues for the fraction of a minute. The circling movements are then again resumed to be followed by a brief interval of spawning. In one case the spawning was observed for an hour and forty minutes, and during this time four or five batches of eggs were laid. At the end of this time the nest contained but few eggs. Upon returning to it next morning many more eggs were found in it, so that the whole time of spawning was undoubtedly several hours.

I may add here a single unrelated observation. The eggs in this locality are much lighter in color than those figured by Whitman and Eycleshymer—so that the nests *may be* very conspicuous when first built—easily seen at a distance of twenty or thirty feet. Later the eggs grow darker and the nest itself less conspicuous. Often, however, even when first built the nests are concealed by logs, stumps, bushes, or the floating stems and leaves of cat-tails, and are then very difficult to find.

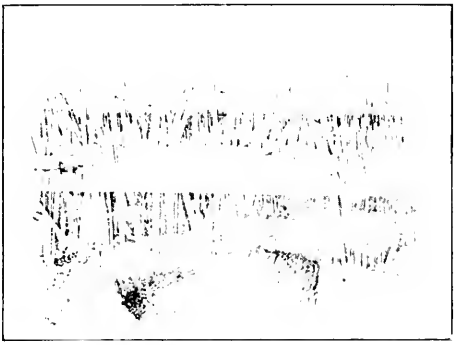

FIG. 1. SKETCH OF AMIA NEST WITH MALE FISH. By permission of Professor Bashford Dean. X about 1-24.

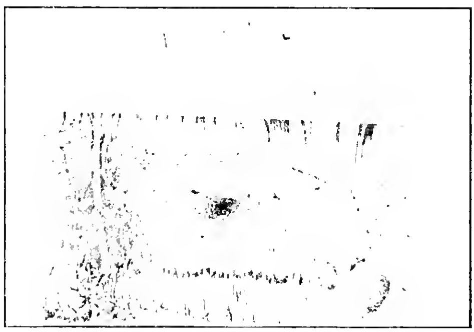

FIG. 2. MALE AMIA WITH SWARM OF YOUNG. By permission of Professor Bashford Dean. X about 1-24.

Summary: (1.) The nests of Amia are built by the male fish a considerable time in advance of spawning.

(2.) They are made by biting and tearing away the aquatic plants or other materials on the bottom, so as to form a concavity, the bottom of which is composed of fibrous roots, gravel, or water-soaked cat-tail leaves or other parts of plants.

(3.) The frequency of the nests depends on the area of available bottom, as compared to the number of spawning fish, and varies within wide limits.

(4.) The spawning occupies several hours and consists of short periods of actual egg laying, alternating with longer periods of circling by the male.

(5.) The same nest may be used by two fish in succession and may contain consequently eggs in widely different stages of development.

(6.) Nests may be very conspicuous or inconspicuous.

Zoölogical Laboratory, University of Michigan, March, 1899.

## THE ORIGIN AND DEVELOPMENT OF THE ADHESIVE ORGAN OF AMIA CALVA.

BY JESSIE PHELPS, YPSILANTI.

[Abstract.]

The adhesive organs of Amia and Lepidosteus and the probable homologous fundaments from which the barbels arise in Acipenser have been described by Dean ('96), Balfour ('81), and V. Kupffer ('91), respectively as of ectodermal origin. Certain sections of Amia embryos which Professor Reighard obtained in 1895, led him to suspect that the organ in this form was of entodermal origin. At his suggestion I have collected evidence which entirely justifies this suspicion and which is presented in what follows:

The adhesive organ of Amia is a larval organ which is functional for only a few days immediately after hatching. At this time the organ consists of a pair of semi-circular or U-shaped ridges, which are so placed on the end of the snout as to form an incomplete ring. Each of these ridges consists of from six to eight cups which open to the surface. The cells of these cups secrete a mucus by which the young animal attaches itself to the water weeds. As far as the general appearance and structure is concerned one might easily conclude that the organ is ectodermal for it is embedded in the surface ectoblast and shows no connection whatever with the entoblast. But by tracing the history of the cells which constitute the organ, they are found to take their origin from among the entodermal cells of the foregut some time before the mouth is formed. At this early period, while the embryo still lies flat upon the yolk, a broad and high dorsally directed enlargement of the anterior extremity of the foregut causes a slight elevation on the exterior immediately in front of the tip of the fore brain. The elevation is crescent shaped and lies with its horns pointing posteriorly. This enlargement or diverticulum of the foregut is the fundament of the adhesive organ. Its walls are composed of a single layer of high columnar cells, which are in contact with the two-layered ectoblast.

In slightly older embryos the crescent shaped area has given place to a pair of hemispherical protuberances which are quite as prominent a feature of the head as the optic vesicles immediately in front of which they lie. In the median line between the two protuberances and directly in front of the tip of the forebrain is a smaller protuberance, or button-like elevation, which is a remnant of the middle part of the crescentic area of the preceding stage, while the two, large paired protuberances are developed from the horns of that area. They each contain a sac-like cavity, which opens widely to the foregut and the cells of the walls are higher and more columnar than before. We now have the fundaments of each of the halves, or U-shaped ridges of the adhesive organ. The original diverticulum has become divided into three diverticula, a small median and two large lateral ones.

In somewhat older eggs in which the embryo extends over about 220 degrees of the circumference and in which both the head and tail are protuberant, the adhesive organ has the form of two U-shaped ridges which lie at the very end of the snout in contact with the optic vesicles and with their concavities directed toward one another and toward the median plane. In fact, they have nearly the position of the ridges in the organ of the newly hatched larvæ described above. The median, button-like elevation is no longer visible. Internally it is found that the diverticula or the paired protuberances of the preceding stage have become extended and have taken on the form of long, curved tubes which open widely as before into the foregut. The cells of these diverticula are directly continuous with those of the foregut; they are more columnar than before and their ends which lie toward the lumina are clear, while the opposite ends are filled with yolk granules. This stage differs from the preceding, mainly in the fact that the paired diverticula have become U-shaped and that the button-shaped elevation has disappeared.

In embryos a very little older than the one just described, no external changes are seen, but sections reveal the fact that the lumina of the diverticula, which are still in connection with the foregut, are divided into alternate wide and narrow portions, so that they present a beaded appearance. The six to eight dilatations, or wider portions, are the fundaments of a series of spherical, closed vesicles, which later give rise to the open cups of the functional organ. The walls of the diverticula continue to be composed of but a single layer of columnar cells in close contact with the very thin ectoblast. No mesenchyme intervenes between the ectoblast and the fundament of the adhesive organ.

The changes which lead from this stage to that of the hatching stage first described, follow each other closely. First: Each of the dilatations becomes independent and forms a closed hollow sphere or vesicle. Those in connection with the foregut are also cut off and the several vesicles lie separate, but close together and in such a manner as to form two U-shaped ridges. The external appearance is as described in the previous stage. Second: The cavities of the vesicles shift their positions so that they lie against the external ectoderm of the snout. The wall of each vesicle is now no longer of the same thickness at all points, nor is the cavity entirely closed by the entoderm. That is, on account of the shifting of the cavities toward the exterior, the outer walls of the vesicle have been pushed back so that now the cavity is closed on the outside by the ectoderm alone. Third: This ectoderm closing the vesicles breaks away and the vesicles are thus converted into the open cups of the functional organ. The walls of the cups consist of a single layer of exceedingly high, columnar, goblet cells, which secrete the mucus that renders the organ adhesive. The two layers of ectoderm come close up to the rims of the cavities and thus make it appear that they are continuous with the walls of the cups. But aside from the historical evidences just stated, the fact of the presence of the yolk material which is found at all times in the cells which constitute the organ, up to and including the hatching stage, marks these cells as entodermal.

As was stated, the adhesive organ remains functionally active during the early life of the larva and enables the animal to attach itself to foreign bodies. As the larva grows stronger and more capable of vigorous muscular activities, the adhesive organ gradually atrophies. As it disappears its cells become vacuolated and leucocytes make their appearance among them. At the same time it is gradually covered in and pushed beneath the surface by the overlying ectoblast which becomes much thickened. By the time the larva is 20 mm. long no external sign of the organ remains. Sections, however, show that it exists below the surface for a few days, at the end of which it entirely disappears. It is interesting to note that in its atrophy it passes through stages which resemble the degenerating notochord, another entodermal organ.

The adhesive organ of Amia is therefore entoblastic and is unique as an instance of a vertebrate organ of entoblastic origin which becomes incorporated in the ectoblast.

## COMPARATIVE STATISTICS OF CLIMATE AND MORTALITY IN MICHIGAN.

BY CRESSY L. WILBUR, M. D., LANSING.

In this brief note I wish to call attention to only a single point, viz., that an opportunity is now presented for making valuable comparisons between the records of meteorology for this State and the statistics of causes of deaths.

This has not been possible until very recently. Our present excellent system of registering deaths went into effect on August 29, 1897, and there was published with the December, 1898, *Bulletin of Vital Statistics* a graphic representation of the relations of the death rates of this State, by months, to the chief elements of sanitary meteorology, temperature and precipitation. Besides the curves representing the total death-rates, lines for two of the most important dangerous communicable diseases, consumption and typhoid fever, are also given. The mortality is further analyzed as urban and rural, thus enabling the study to embrace the well known effects of density of population, and according to its distribution in the four geographical sections of the State. The latter are the same as employed by the Michigan Weather Service, thus enabling comparisons to be made with facility.

The accompanying table gives rates for several other important causes of death, whose graphic representation would be of great interest.

Besides the rates for Michigan, death rates are presented for the States of Connecticut, New York, and for the Province of Ontario, in all of which mortality statistics are collected and promptly published soon after the end of each month. There is a favorable prospect also that data from Indiana and Wisconsin may soon be available for this purpose.

As it is, we have statistics of the most important causes of death for Michigan and other states representing an aggregate population of about one-seventh of the United States, available for comparative study in connection with the statistics of weather, within 30 days after the close of each month. The timely interest of such studies is obvious, as they may be made while the phenomena considered are still fresh in the minds of the people.

It is the purpose of calling attention to this fact and of soliciting the interest of the members of this Academy in this class of work that excuses the presentation of this hastily prepared paper. For obvious reasons, the detailed analysis of the data of mortality and weather, in all its bearings, is impossible within the reasonable limits and scope of a monthly report. In such a report it is only possible, as a rule, to provide the raw material, in as convenient a form for use as possible, and its further study must depend on the number and activity of those interested. Since the discontinuance of *Climate and Health*, published a short time by the United States Department of Agriculture, there has been no systematic attempt to make such comparative studies for any considerable portion of the United States, and hence the field is practically unoccupied. Should any member of the Academy desire, I presume that the directors of Vital Statistics of the states now publishing monthly bulletins would be pleased to send them regularly for the purpose of comparative study, and so far as the Michigan service is concerned, we shall not only be glad to cordially co-operate in supplying the data for such work, but may also be able, to some degree, to assist in presenting such papers to the attention of students of meteorology and demography through the pages of the *Bulletin*.

Lansing, Mich., March 27, 1899.

*Comparative mortality of Michigan, Connecticut, New York and Ontario during the first sixteen months of registration in Michigan, with meteorological data.*

| | States. | Sept., 1897. | Oct., 1897. | Nov., 1897. | Dec., 1897. | Jan., 1898. | Feb., 1898. | March, 1898. | April, 1898. | May, 1898. | June, 1898. | July, 1898. | Aug., 1898. | Sept., 1898. | Oct., 1898. | Nov., 1898. | Dec. 1898. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALL CAUSES | Mich. | **13.4** | **12.8** | **11.1** | **11.3** | **12.1** | **12.8** | **13.8** | **14.3** | **12.6** | **11.0** | **11.3** | **12.5** | **13.8** | **12.3** | **11.6** | **11.9** |
| | Conn. | **15.4** | **14.9** | **14.3** | **14.7** | **15.6** | **15.2** | **17.3** | **16.3** | **15.4** | **13.2** | **16.4** | **18.8** | **18.1** | **14.9** | **13.7** | **16.5** |
| | N. Y. | **17.8** | **16.8** | **15.3** | **16.8** | **17.0** | **17.6** | **18.3** | **18.1** | **17.2** | **16.0** | **20.6** | **20.0** | **20.8** | **16.5** | **15.8** | **19.0** |
| Per cent of deaths under five years to total deaths | Mich. | 35.2 | 31.0 | 21.9 | 22.3 | 23.8 | 21.7 | 23.0 | 23.9 | 24.8 | 23.9 | 31.1 | 35.7 | 37.4 | 28.6 | 20.4 | 21.5 |
| | Conn. | 32.7 | 23.7 | 21.3 | 22.8 | 20.5 | 24.3 | 26.1 | 25.3 | 21.6 | 26.9 | 38.0 | 42.9 | 38.0 | 27.7 | 20.5 | 20.1 |
| | N. Y. | 35.5 | 22.6 | 24.5 | 25.0 | 25.0 | 27.5 | 28.0 | 28.0 | 27.0 | 30.0 | 43.0 | 42.5 | 37.5 | 30.0 | 22.7 | 21.0 |
| Consumption | Mich. | 113.3 | 89.8 | 110.4 | 109.7 | 110.2 | 130.0 | 119.7 | 125.0 | 113.7 | 107.3 | 82.7 | 100.9 | 91.0 | 106.1 | 90.1 | 109.4 |
| | Conn. | 170.8 | 164.3 | 150.7 | 181.2 | 185.7 | 153.2 | 178.1 | 203.3 | 167.0 | 128.4 | 115.0 | 137.4 | 142.1 | 147.1 | 160.0 | 154.8 |
| | N. Y. | 185.5 | 197.2 | 179.8 | 192.9 | 185.5 | 197.0 | 206.6 | 198.6 | 198.2 | 186.5 | 200.9 | 180.3 | 194.5 | 180.2 | 189.7 | 207.0 |
| Tuberculosis | Ont. | 107.7 | 102.9 | 112.2 | 122.9 | 112.1 | 113.8 | 104.1 | 143.7 | 117.7 | 116.4 | 77.8 | 82.2 | 82.9 | 82.1 | 82.7 | 76.5 |
| Typhoid fever | Mich. | 28.8 | 38.1 | 36.4 | 21.0 | 13.2 | 18.2 | 11.8 | 13.8 | 12.8 | 15.5 | 10.7 | 29.0 | 49.1 | 55.1 | 40.8 | 15.8 |
| | Conn. | 44.7 | 32.6 | 17.7 | 18.9 | 22.7 | 7.4 | 9.4 | 4.1 | 17.4 | 9.6 | 14.5 | 21.1 | 46.4 | 61.0 | 32.8 | 37.0 |
| | N. Y. | 29.1 | 32.0 | 27.9 | 29.7 | 21.5 | 19.9 | 21.1 | 14.4 | 15.1 | 13.0 | 16.0 | 32.0 | 60.2 | 48.1 | 34.2 | 27.3 |
| | Ont. | 34.4 | 39.2 | 30.0 | 19.9 | 10.0 | 16.3 | 8.1 | 7.5 | 9.1 | 7.3 | 10.9 | 18.4 | 24.8 | 29.0 | 28.3 | 11.4 |
| Scarlet fever | Mich. | 4.5 | 5.4 | 3.4 | 5.9 | 6.3 | 6.2 | 6.7 | 4.3 | 2.6 | 2.1 | .5 | 2.5 | 2.1 | 3.1 | 2.7 | 7.6 |
| | Conn. | 4.1 | 4.1 | 4.1 | 4.1 | 4.0 | 4.4 | 2.7 | 2.8 | 6.7 | 4.1 | 4.0 | 2.6 | .0 | 2.7 | 5.5 | 1.3 |
| | N. Y. | 5.8 | 9.0 | 11.2 | 16.2 | 21.7 | 17.8 | 19.1 | 15.2 | 19.9 | 15.2 | 10.6 | 4.6 | 4.7 | 6.5 | 5.8 | 9.3 |
| | Ont. | 2.6 | 0 | 4.4 | 4.5 | 12.3 | 12.8 | 21.0 | 11.6 | 11.9 | 6.5 | 8.2 | 5.4 | 6.2 | .5 | 9.6 | 5.4 |
| Diphtheria and croup. | Mich. | 25.3 | 50.6 | 42.5 | 39.3 | 26.9 | 22.7 | 14.9 | 15.4 | 14.8 | 15.0 | 9.7 | 11.7 | 16.2 | 28.1 | 24.9 | 25.4 |
| | Conn. | 29.8 | 96.4 | 61.1 | 54.1 | 49.4 | 29.5 | 40.2 | 36.0 | 25.4 | 21.9 | 15.9 | 15.9 | 16.4 | 37.1 | 57.4 | 46.3 |
| | N. Y. | 47.9 | 68.3 | 62.3 | 61.1 | 57.0 | 52.5 | 49.8 | 45.5 | 39.2 | 32.2 | 28.6 | 21.9 | 24.4 | 30.8 | 43.8 | 42.6 |
| | Ont. | 21.2 | 38.4 | 38.0 | 35.2 | 39.2 | 32.5 | 21.8 | 10.0 | 11.2 | 21.1 | 8.8 | 8.6 | 18.6 | 20.9 | 33.4 | 27.7 |
| Measles | Mich. | 1.1 | .5 | 3.9 | 3.2 | 4.2 | 5.7 | 9.2 | 9.6 | 9.7 | 5.9 | 5.6 | 2.5 | 1.0 | 3.1 | 1.1 | 1.0 |
| | Conn. | 0 | 2.7 | 2.7 | 4.1 | 12.0 | 19.2 | 8.0 | 12.4 | 13.4 | 8.2 | 2.6 | 4.0 | 1.4 | 1.3 | ....... | 1.3 |
| | N. Y. | 3.5 | 6.1 | 11.6 | 12.1 | 19.8 | 16.0 | 25.5 | 22.7 | 19.2 | 18.3 | 9.4 | 4.6 | 3.6 | 1.7 | 3.3 | 6.6 |
| | Ont. | 3.5 | .9 | 2.7 | 0 | 3.1 | 7.7 | 3.2 | 5.8 | 10.5 | 5.1 | 9.8 | 3.2 | 1.1 | 2.1 | 3.4 | 1.1 |
| Whooping cough | Mich. | 7.3 | 8.2 | 4.5 | 3.2 | 5.8 | 6.8 | 6.7 | 12.8 | 11.3 | 13.3 | 20.4 | 18.3 | 20.9 | 9.2 | 6.9 | 9.2 |
| | Conn. | 14.9 | 12.2 | 6.8 | 12.2 | 9.4 | 14.7 | 13.4 | 15.2 | 24.0 | 20.5 | 15.9 | 23.8 | 26.0 | 11.9 | 4.1 | 7.9 |
| | N. Y. | 14.1 | 10.9 | 5.0 | 7.9 | 7.8 | 9.0 | 15.8 | 21.3 | 19.7 | 20.6 | 31.7 | 29.7 | 21.7 | 10.1 | 9.4 | 10.3 |
| | Ont. | 10.6 | 2.6 | 8.0 | 11.7 | 6.1 | 8.6 | 0.8 | 3.3 | 6.3 | 5.1 | 6.6 | 6.5 | 7.3 | 4.3 | 3.4 | 6.5 |
| Pneumonia | Mich. | 32.1 | 48.4 | 81.8 | 125.3 | 153.5 | 163.5 | 192.6 | 175.0 | 149.5 | 63.0 | 39.3 | 32.6 | 52.3 | 58.1 | 100.2 | 116.0 |
| | Conn. | 52.9 | 100.5 | 127.7 | 154.2 | 212.4 | 206.3 | 221.0 | 204.7 | 160.3 | 60.1 | 70.0 | 33.0 | 62.8 | 75.6 | 120.2 | 166.7 |
| Acute respiratory diseases | N. Y. | 145.6 | 201.0 | 212.4 | 282.2 | 311.5 | 332.0 | 331.7 | 337.4 | 277.2 | 158.8 | 127.8 | 108.5 | 138.8 | 178.8 | 232.9 | 393.0 |

*Comparative mortality of Michigan, Connecticut, New York and Ontario during the first sixteen months of registration in Michigan, with meteorological data.*—CONTINUED.

| | States. | Sept., 1897. | Oct., 1897. | Nov., 1897. | Dec., 1897. | Jan., 1898. | Feb., 1898. | March, 1898. | April, 1898. | May, 1898. | June, 1898. | July, 1898. | Aug., 1898. | Sept., 1898. | Oct., 1898. | Nov., 1898. | Dec., 1898. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diarrheal diseases under five years | Mich... | 243.6 | 141.8 | 34.2 | 19.9 | 16.9 | 17.0 | 13.9 | 25.0 | 23.0 | 37.9 | 136.2 | 222.7 | 252.5 | 119.4 | 25.4 | 16.3 |
| | Conn... | 189.8 | 57.0 | 23.1 | 9.5 | 12.0 | 7.4 | 26.8 | 11.1 | 20.0 | 68.3 | 299.9 | 496.8 | 370.2 | 106.0 | 17.8 | 15.9 |
| Diarrheal diseases—all ages | N. Y... | 216.8 | 81.7 | 35.2 | 21.8 | 19.9 | 22.7 | 21.8 | 24.7 | 22.3 | 68.9 | 413.6 | 415.0 | 338.3 | 117.7 | 29.8 | 24.6 |
| Cerebro-spinal meningitis | Mich... | 14.1 | 16.9 | 8.4 | 10.2 | 15.3 | 12.5 | 18.0 | 20.2 | 23.6 | 20.8 | 15.8 | 20.4 | 21.4 | 14.3 | 14.3 | 14.7 |
| | Conn... | 10.8 | 1.4 | 5.4 | 10 8 | 13.4 | 8.8 | 16.1 | 20.7 | 24.0 | 23.2 | 11.9 | 25.1 | 9.6 | 2.7 | 1.4 | 4.0 |
| | N. Y... | 9.4 | 5.5 | 5.7 | 5.1 | 6.0 | 10.1 | 12.9 | 14.8 | 14.3 | 20.2 | 12.2 | 7.1 | 8.5 | 6.3 | 6.5 | 6.1 |
| Average temperature—degrees Fahrenheit. | Mich... | 63.3 | 52.2 | 33.9 | 24 3 | 23.9 | 22.4 | 35.4 | 42.3 | 55.1 | 65.7 | 69.9 | 67.4 | 63.0 | 49.1 | 34.6 | 23.1 |
| | Conn... | 62.9 | 53.5 | 41.9 | 34.0 | 29.- | 31.- | 42.- | 45.- | 56.- | 67.- | 72.- | 72.- | 67.- | 54.- | 41.- | 31.- |
| | N. Y... | 61.0 | 51.0 | 39.0 | 29.0 | 23.0 | 26.0 | 40.0 | 42.7 | 56.5 | 67.0 | 72.5 | 70.0 | 65.0 | 53.0 | 39.0 | 28 0 |
| Precipitation—inches... | Mich... | 1.30 | 2.34 | 3.12 | 2.41 | 2.91 | 2.36 | 3.20 | 1.66 | 2.53 | 3.61 | 1.57 | 2.88 | 2.76 | 4.38 | 2.56 | 1.87 |
| | Conn... | 2.42 | 1.25 | 5.72 | 5.61 | 4.96 | 4 55 | 2.54 | 4.43 | 8.03 | 0.21 | 5.03 | 6.65 | 2.30 | 7.22 | 5.69 | 2.11 |
| | N. Y... | 1.35 | 0.93 | 4.73 | 3.90 | 4.19 | 2.8 | 2.11 | 2.65 | 4.15 | 2.83 | 3.00 | 5.00 | 3.00 | 5. 15 | 4.10 | 2.42 |

NOTE.—The death rates in **bold-face** type are per 1,000 estimated population. The rates for individual diseases are per 100,000 estimated population. Allowances must be made in comparing the rates given in this table for differences of density of population, age distribution, etc.

## NEW PROBLEMS AND NEW PHASES OF OLD ONES.

BY CLINTON D. SMITH, AGRICULTURAL COLLEGE.

I shall attempt, briefly, to state something about some of the problems that confront the thinker and worker along lines of agricultural progress without stopping to discuss any one of them at all thoroughly.

Whoever is interested in the literature relating to soils has noted the trend away from chemistry and towards physics in the recent discussions relating to the proper treatment and fertilization of fields. Formerly it was supposed that the chemical constitution of the soil was a sufficient guide as to what the soil would do and what it needed to make it grow any one of our common cereals. The opposition of practical experience to this theory was attributed to the ignorance of the objector. Now we are studying the physical side of the questions much more, perhaps, than the chemical. Water is the greater desideratum in plant growth. How can we hold the rain falling in the spring for the use of crops growing in the late summer is the great problem presented to the practical farmer and not how to retain the nitrogen, phosphoric acid and potash, important as that question is. Hence comes the importance attached to humus and the stress laid upon the application of barn yard manure or plowing under green crops as a means of maintaining fertility. Formerly the value of manure was estimated entirely by the amount of nitrogen and other plant elements it contained, now it is valued because it contributes decaying vegetable matter to the soil and thus helps the physical, water holding, capacity of the soil.

Cultivation is likewise carried on with this idea of conservation of moisture clearly in mind. The fact that, through the bulletins of experiment stations, and later through the current agricultural press, the knowledge of the correct principles in this matter has been widely disseminated, makes possible the successful culture of certain new crops in this State that would not be here at all without this improvement in method.

The careful work of the scientist in the study of fungus and insect enemies of fruits, cereals and vegetables is yielding an abundant harvest of good to the State at large. No sooner does a new disease attack any valuable plant than the scientist interested in the department involved is working out a life history and suggesting proper remedies. Thanks to the cryptogamic botanist we know how to ward off most of the diseases that afflict our fruit trees, but we have yet other work for him to do. Who shall diagnose the cause of peach yellows, little peach, crown gall, or rosette? The work in this line is just begun and new problems are constantly confronting us.

He who is interested in combating destructive insects may find his best ingenuity put to the test to suggest a remedy for the threatening gypsy moth, the introduction of which into Michigan would mean the practical annihilation, not only of the fruit trees but of the forests themselves.

I will not take up your time by suggesting problems that confront the practical agriculturist, farther than to refer to some that relate to the new industry recently assuming gigantic proportions in the Peninsular State. The widespread attempt to raise sugar beets by farmers who know nothing about the industry is going to call for the best wisdom of the scientific men of the State, to prevent fatal mistakes. It is going to call for a vast deal of original work in all phases of the subject. The experiments we have already carried on have demonstrated the futility of relying upon German dicta for our guidance. The whole subject must be studied anew in this country. Let me illustrate:

One of the most important matters that we shall have to attend to in the development of this industry is the growing of thoroughbred seed. This involves the careful selection of the mother beets by the polariscope, then the growing of the selected mothers under the best conditions, the preservation of the seed of each separately and the selection the next year of the strain offering the greatest number of rich beets conforming to the chosen type. Thereafter the chemist must keep in close control of the seed growing and thousands of dollars must be spent annually in analyses of beets to prevent reversion to the normal low content of sugar. American ingenuity is to be put to the test to accomplish the production of reliable seed without the cumbrous methods now in vogue in Germany. The matter is of the most immediate importance, the growing of seed must begin in 1899 or the immediate future of the sugar production is in danger.

A second necessity confronts us in this sugar beet business, namely, the necessity of inventing some way of preventing waste of so much seed in the beet field. The Michigan Experiment Station, which in 1890 and 1891 was the first to call attention to the growing of sugar beets in Michigan, will conduct a series of experiments this year along this line. I have visited some twenty-six counties in the State, lecturing to farmers, who are wild with excitement, ready to believe anything in regard to the method of growing the beets, and in constant danger of being misled by interested parties and I have found one of the chief dangers to lie in their willingness to accept second rate seed, because they are ignorant of its quality and their anxiety to sow as small a quantity of seed as possible. As long as the seed is imported from Germany and we have no better guaranty of its germination and vitality than the good will of the German Emperor to the American sugar industry, we will do well not to stint the amount used. A good stand is absolutely essential and to secure it we must have enough seed sown to produce a strong beet every two inches.

A third problem presented by this new industry is the avoidance of the excessive labor of thinning. How this is to be done is not yet clear, but that it must be done is strongly urged and that it will be done is manifest when one thinks that the problem is in the hands of Americans justly noted for their ingenuity. A fourth problem relates to a better method of harvest, whereby the present excessive labor may be dispensed with.

Turning now to the side of the factory, we find our ambition to go at inconsiderate speed into putting up factories confronted by the certainty, well nigh absolute, that within a couple of years our present expensive and, it must be confessed, clumsy machinery and methods of manufacturing, will be displaced by simpler, more economical and more efficient apparatus. I have but to refer to the experiments going on in Belgium and also in Austria where, by the use of an electrolytic method the crystalization of the sugar from the purified juices is greatly expedited and is much more economically accomplished.

It may be rightfully supposed that the chemicals found in nature produce the same results in America that they do in Europe, but much light is needed to answer the question what are the real melassigenic salts? We have condemned certain chlorides and carbonates, to the point of prohibiting the use of water containing them. Others we have pronounced harmless. We have certainly done it without sufficient authoritative experiments in this country.

In conclusion, I refer to the desirability of improved chemical methods in the factory whereby justice to the patron bringing beets may be better assured and whereby the matter may be somewhat expedited.

# CONSTITUTION

OF THE

# MICHIGAN ACADEMY OF SCIENCE.

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## ARTICLE I.

This Society shall be known as THE MICHIGAN ACADEMY OF SCIENCE.

## ARTICLE II: OBJECTS.

The objects of this Academy shall be scientific research and the diffusion of knowledge concerning the various departments of science.

## ARTICLE III: MEMBERSHIP.

The Academy shall be composed of *Resident Members, Corresponding Members, Honorary Members, and Patrons.*

1. Resident Members shall be persons who are interested in scientific work and resident in the State of Michigan.
2. Corresponding Members shall be persons interested in science, and not resident in the State of Michigan.
3. Honorary Members shall be persons distinguished for their attainments in science, and not resident in the State of Michigan, and shall not exceed twenty-five in number.
4. Patrons shall be persons who have bestowed important favors upon the Academy, as defined in Chapter I, Paragraph 4 of the By-Laws.
5. Resident Members alone shall be entitled to vote and hold office in the Academy.

## ARTICLE IV: OFFICERS.

1. The officers of the Academy shall consist of a President, a Vice-President of each Section that may be organized, a Secretary, and a Treasurer.

These officers shall constitute an Executive Committee, which shall be called the *Council.*

[This last sentence was amended April 1, 1898, to read as follows: These officers, *and all past presidents*, shall constitute an executive committee which shall be called the Council.]

2. The PRESIDENT shall discharge the usual duties of a presiding officer at all meetings of the Academy, and of the Council. He shall take cognizance of the acts of the Academy and of its officers, and cause the provisions of the Constitution and By-Laws to be faithfully carried into effect. He shall also give an address to the Academy at the closing meeting of the year for which he is elected.

3. The duties of the President in case of his absence or disability shall be assumed by one of the Vice-Presidents who shall be designated by the Council.

The VICE-PRESIDENTS shall be chairmen of their respective Sections. They shall encourage and direct research in the special branches of science included within the Sections over which they preside.

4. The SECRETARY shall keep the records of the proceedings of the Academy, and a complete list of the members, with the dates of their election and disconnection with the Academy. He shall also be the Secretary of the Council.

The SECRETARY shall co-operate with the President in attending to the ordinary affairs of the Society. He shall attend to the preparation, printing and mailing of circulars, blanks, and notifications of elections and meetings. He shall superintend other printing ordered by the Academy, or by the President, and shall have charge of its distribution under the direction of the Council.

The SECRETARY, unless other provision be made, shall also act as *Editor* of the publications of the Academy and as *Librarian* and *Custodian* of property.

5. The TREASURER shall have the custody of all funds of the Academy. He shall keep an account of receipts and disbursements in detail, and this account shall be audited as hereinafter provided.

6. The Academy may elect an *Editor* to supervise all matters connected with the publication of the transactions of the Academy, under the direction of the Council, and to perform the duties of Librarian until such time as the Academy shall make that an independent office.

7. The COUNCIL is clothed with executive authority, and with the legislative powers of the Academy in the intervals between the latter's meetings; but no extraordinary act of the Council shall remain in force beyond the next following stated meeting, without ratification by the Academy. The Council shall have control of the publications of the Academy, under the provisions of the By-Laws and of resolutions from time to time adopted. It shall receive nominations for members, and on approval, shall submit such nominations to the Academy for action. It shall have power to fill vacancies *ad interim*, in any of the offices of the Academy.

8. TERMS OF OFFICE. The *President* and *Treasurer* shall be elected annually, and shall not be eligible to re-election for an interval of three years after retiring from office. The *Vice Presidents*, *Secretary*, and the *Editor* shall be elected annually and be eligible to re-election without limitation. [Section 8 was amended April 1, 1898, to read as follows: The President, Vice Presidents, Secretary, Treasurer, and Editor shall be elected annually, and be eligible to re-election without limitation.]

## ARTICLE V: Voting and Elections.

1. All *elections* shall be by ballot. To elect a Resident Member, Corresponding Member, Honorary Member, or Patron, or impose any special tax shall require the assent of three-fourths of all Resident Members voting.

2. Any member may be expelled by a vote of nine-tenths of all members voting, providing notice that such a movement is contemplated be given at a meeting of the Academy three months previous to such action.

3. Election of Members. Nominations for Resident membership shall be made by two Resident Members, according to a form to be provided by the Council. One of these Resident Members must be personally acquainted with the nominee and his qualifications for membership. The Council shall submit the nominations received by them, if approved, to a vote of the Academy at a regular meeting.

4. Election of Officers. Nominations for office shall be made by the Council as provided in the By-Laws. The nominations shall be submitted to a vote of the Academy at its winter [Annual] meeting. The officers thus elected shall enter upon duty at the adjournment of the meeting.

5. At the meeting in which this Constitution is adopted the officers for the ensuing year shall be elected in such manner as the Academy may determine.

## ARTICLE VI: Meetings.

1. The Academy shall hold at least two stated meetings a year—a *Summer* [*or Field*] *Meeting*, and a *Winter* [*or Annual*] *Meeting*. The date and place of each meeting shall be fixed by the Council, and announced by circular at least three months before the meeting. The programme of each meeting shall be determined by the Council, and announced beforehand, in its general features. The details of the daily sessions shall also be arranged by the Council.

2. All members must forward to the Secretary, if possible before the convening of the Academy, full titles of all papers which they propose to present during the meeting, with a statement of the time that each will occupy in delivery and a brief abstract of their contents. From the abstracts thus presented, the Council will determine the fitness of the paper for the programme.

3. At the Winter meeting the election of officers shall take place, and the officers elect shall enter upon duty at the adjournment of the meeting. [This section stricken out, April 1, 1898.]

4. Special Meetings of the Academy may be called by the Council, and must be called upon the written request of twenty Resident Members.

5. Stated Meetings of the Council, shall be held coincidently with the stated meetings of the Academy. Special meetings of the Council may be called by the President at such times as he may deem necessary.

6. Quorum. At meetings of the Academy a majority of those registered in attendance shall constitute a quorum. A majority shall constitute a quorum of the Council. [Amended April 1, 1898, to read "Four members shall constitute a quorum of the Council."]

### ARTICLE VII: Publications.

The publications of the Academy shall be under the immediate control of the Council, but the Council shall accord to each author the right, under proper restrictions, to publish through whatever channel he may choose.

### ARTICLE VIII: Sections.

Members not less than eight in number may by special permission of the Academy unite to form a Section for the investigation of any branch of science. Each Section shall bear the name of the science which it represents, thus: The Section of (Agriculture) of the Michigan Academy of Science.

2. Each Section is empowered to perfect its own organization as limited by the Constitution and By-Laws of the Academy.

### ARTICLE IX: Amendments.

This Constitution may be amended at any Winter [Annual] meeting by a three-fourths vote of all the Resident Members present, provided that notice of the proposed amendment shall have been given at a previous meeting. [Amended, April 1, 1897, by striking out the last fifteen words.]

# BY-LAWS.

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## CHAPTER I: MEMBERSHIP.

1. No person shall be accepted as a Resident Member unless he pay his initiation fee, and the dues for the year, within three months after notification of his election. The initiation fee shall be one (1) dollar and the annual dues one (1) dollar, the latter payable on or before the annual meeting in advance; but a single pre-payment of twenty-five (25) dollars shall be accepted as commutation for life.

2. The sums paid in commutation of dues shall be invested, and the interest used for the ordinary purposes of the Academy during the payer's life, but after his death the sum shall be covered into the Research Fund.

3. An arrearage in payment of annual dues shall deprive a Resident Member of the privilege of taking part in the management of the Academy and of receiving the publications of the Academy. An arrearage continuing over two (2) years shall be construed as notification of withdrawal.

4. Any person eligible under Article III of the Constitution, may be elected Patron upon the payment of one hundred (100) dollars to the Research Fund of the Academy.

## CHAPTER II: OFFICIALS.

1. The PRESIDENT shall countersign, if he approves, all duly authorized accounts and orders drawn on the Treasurer for the disbursement of money.

2. The SECRETARY, until otherwise ordered by the Academy, shall perform the duties of Editor, Librarian, and Custodian of the property of the Society.

3. The Academy may elect an ASSISTANT SECRETARY.

4. The TREASURER shall give bonds, with two good sureties approved by the Council, in the sum of five hundred dollars, for the faithful and honest performance of his duties, and the safe-keeping of the funds of the Academy. He may deposit the funds in bank at his discretion, but shall not invest them without the authority of the Council. His accounts shall be balanced on the thirtieth day of November of each year. [Last sentence amended April 1, 1898, to read "His accounts shall be balanced on the first day of the Annual Meeting of each year."]

5. The minutes of the proceedings of the Council shall be subject to call by the Academy.

## CHAPTER III: ELECTION OF MEMBERS.

1. Nominations for Resident Membership may be proposed at any time on blanks to be supplied by the Secretary.

2. The *form* for the nomination of Resident Members shall be as follows:

In accordance with his desire, we respectfully nominate for Resident Member of the Michigan Academy of Science
(Full name)
(Address)
(Occupation)
(Branch of Science interested in, work already done, and publications if any)
(Signed by at least two Resident Members)

The form when filled is to be transmitted to the Secretary.

3. The Secretary shall bring all nominations before the Council at either the winter [Annual] or summer [Field] meeting of the Academy, and the Council shall signify its approval or disapproval of each.

4. At the same or the next stated meeting of the Academy, the Secretary shall present the list of candidates to the Academy for election.

5. Corresponding Members, Honorary Members, and Patrons shall be nominated by the Council, and shall be elected in the same manner as Resident Members.

## CHATER IV: ELECTION OF OFFICERS.

1. The Council shall designate three candidates for each office, except the offices of Vice-Presidents, for which but single candidates shall be named.

2. Each Section may recommend to the Council a candidate for Vice-President.

3. The *form* for the nomination and election of officers, unless otherwise provided by the Council, shall be as follows:

The Council nominates for officers of the Michigan Academy of Science, for the ensuing year the following persons:

(The voter will indicate his preference out of each of the sets of names below by erasing, except for Vice-Presidents, the two other names in each set, or will substitute the name of his choice.)

| | |
|---|---|
| For President, | 1.<br>2.<br>3. |
| For Vice-President, | Section ........<br>Section ........<br>Section ........ |
| For Secretary, | 1.<br>2.<br>3. |
| For Treasurer, | 1.<br>2.<br>3. |

The Secretary shall distribute a copy of this ballot to each member at the Winter Meeting.

4. In case a majority of all the ballots shall not have been cast for one of the three candidates for an office, the Society shall by ballot at

such Winter Meeting, proceed to make an election for such office from the two candidates having the highest number of votes. [Chapter IV of the By-Laws was amended April 1, 1898, to read as follows:

Section 1. At the Annual Meeting the election of officers shall take place, and the officers elected shall enter on their duties at the end of the meeting.

Section 2. The Council shall nominate a candidate for each office, but each Section may recommend to the Council a candidate for its Vice-President. Additional nominations may be made by any member of the Academy. All elections shall be made by ballot. Sections 3 and 4 repealed.]

## CHAPTER V: Financial Methods.

1. No pecuniary obligation shall be contracted without express sanction of the Academy or the Council. But it is to be understood that all ordinary, incidental and running expenses have the permanent sanction of the Academy, without special action.

2. The creditor of the Academy must present to the Treasurer a fully *itemized* bill, *certified* by the official ordering it, and *approved* by the President. The Treasurer shall then pay the amount out of any funds not otherwise appropriated, and the receipted bill shall be held as his voucher.

3. At each annual meeting, the President shall call upon the Academy to choose two members, not members of the Council, to whom shall be referred the books of the Treasurer, duly posted and balanced to the close of November thirtieth, [to the first day of the Annual Meeting] as specified in the By-Laws, Chapter II, Paragraph 4. These Auditors shall examine the accounts and vouchers of the Treasurer, and any member or members of the Council may be present during the examination. The report of the Auditors shall be rendered to the Academy before the adjournment of the meeting and the Academy shall take appropriate action.

## CHAPTER VI: Publications.

1. The publications are in charge of the Council and under their control, limited only as given by Article VII, of the Constitution.

2. One copy of each publication shall be sent to each Resident Member, Corresponding Member, Honorary Member, and Patron, and each author shall receive fifty copies of his memoir. This provision shall not be understood as including publications in journals not controlled by the Academy.

## CHAPTER VII: The Research Fund.

1. The Research Fund shall consist of moneys paid by the general public for publications of the Academy, of donations made in aid of research, and of the sums paid in commutation of dues according to the By-Laws, Chapter I, Paragraphs 2 and 4.

2. Donors to this fund, not Members of the Academy, in the sum of twenty-five dollars, shall be entitled without charge, to the publications subsequently appearing.

## CHAPTER VIII: Order of Business.

1. The Order of Business at the Winter [Annual] Meetings shall be as follows:

(1) Call to order by the Presiding Officer.
(2) Introductory ceremonies.
(3) Statements by the President.
(4) Report of the Council.
(5) Report of the Treasurer, and appointment of the Auditing Committee.
(6) Election of officers of the next ensuing Administration.
(7) Election of Members.
(8) Announcement of the hour and place for the Address of the retiring President.
(9) Necrological notices.
(10) Miscellaneous announcements.
(11) Business motions and resolutions, and disposal thereof.
(12) Reports of committees, and disposal thereof.
(13) Miscellaneous motions and resolutions.
(14) Presentation of memoirs.

2. At an *adjourned session*, the order shall be resumed at the place reached on the previous adjournment, but new announcements, motions and resolutions, will be in order before the resumption of the business pending at the adjournment of the last preceding session.

3. At the Summer [Field] Meeting, the items of business under numbers (5), (6), (8), (9), shall be omitted.

4. At any Special Meeting the Order of Business shall be (1), (2), (3), (7), (10), followed by the special business for which the meeting was called.

## CHAPTER IX. Amendments.

These By-Laws may be amended by a majority vote of the members present at any regular meeting, provided that notice of the substance of the proposed amendment has been given at a previous regular meeting. [Amended, April 1, 1897, by striking out the last eighteen words.]

# LIST OF MEMBERS

OF THE

# MICHIGAN ACADEMY OF SCIENCE.

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This list includes the names of all persons who have been actual members of the Academy at any time, but does not include those who have been elected but have declined membership or failed to qualify. Names of actual Resident Members, on June 30, 1899, are preceded by an asterisk (*); names of Charter Members are in capitals.

## RESIDENT MEMBERS.

*HENRY C. ADAMS, LL. D., University of Michigan, Ann Arbor.
E. Arnold, Battle Creek. (Resigned.)
HATTIE M. BAILEY, Grand Rapids. (Resigned.)
*HENRY B. BAKER, M. D., Lansing.
*Howard B. Baker, M. D., Lansing. (Removed from State.)
Luther H. Baker, Lansing. (Resigned.)
Enoch Bancker, Jackson. (Resigned.)
*CHARLES E. BARR, Albion College, Albion.
*WALTER B. BARROWS, Michigan Agricultural College, Agricultural College P. O.
*Arthur G. Baumgartel, 232 River St., Holland.
*WILLIAM J. BEAL, PH. D., Michigan Agricultural College, Agricultural College P. O.
*HERBERT T. BLODGETT, Ludington.
Albert H. Boies, Hudson. (Resigned.)
Cheshire L. Boone, Ypsilanti. (Resigned.)
*George Booth, 1102 Center Ave., Bay City.
*Frank Bradley, Alma.
*E. E. Brewster, Iron Mountain.
*Alice Brown, Ann Arbor.
*William A. Brush, 64 Hastings St., Detroit.
*Mrs. Laura E. Burr, Lansing.
*Benjamin F. Bush, Grand Blanc.
CHARLES K. CARPENTER, Ann Arbor. (Resigned.)
*Flemming Carrow, M. D., University of Michigan, Ann Arbor.

*George H. Cattermole, M. D., Lansing.
*Harvey H. Chase, M. D., Linden.
*FRANCIS D. CLARKE, M. D., Flint.
*T. P. Clark, Flint.
*Mrs. Frank I. Cobb, 391 Cass Ave., Detroit.
FRANK N. COLE, Ann Arbor. (Removed from State.)
*Leon J. Cole, 703 Church St., Ann Arbor.
*LEARTUS CONNOR, M. D., 103 Cass Ave., Detroit.
*W. M. COURTIS, A. M., 449 Fourth Ave., Detroit.
*Paul A. Cowgill, Cassopolis.
ARTHUR A. CROZIER, Ann Arbor. (Died January 28, 1899.)
*CHARLES A. DAVIS, Alma College, Alma.
GAGER C. DAVIS, M. S., Agricultural College. (Removed from State.)
*JOSEPH B. DAVIS, C. E., University of Michigan, Ann Arbor.
*Fisk H. Day, M. D., Lansing.
ISAAC N. DEMMON, LL. D., University of Michigan, Ann Arbor. (Resigned.)
*CHARLES K. DODGE, Port Huron.
*Myron T. Dodge, Bearinger Building, Saginaw, E. S.
*NEWELL A. EDDY, 615 N. Grant St., Bay City.
EDWIN H. EDWARDS, University of Michigan, Ann Arbor. (Resigned.)
*Delos Fall, M. D., Albion College, Albion.
*OLIVER A. FARWELL, 1225 Jefferson Ave., Detroit.
*Hester T. Fuller, Greenville, Mich.
CHARLES W. GARFIELD, Grand Rapids. (Resigned.)
HENEAGE GIBBES, University of Michigan, Ann Arbor. (Resigned.)
MORRIS GIBBS, M. D., Kalamazoo.
A. C. GLIDDEN, Paw Paw. (Resigned.)
E. A. A. Grange, V. S. Detroit. (Removed from State.)
*Mary E. Green, M. D., Charlotte.
*William M. Gregory, East Tawas.
*Thomas Gunson, Agricultural College.
*ASAPH HALL, Jr., Ph. D., University of Michigan, Ann Arbor.
*Thomas L. Hankinson, Hillsdale.
Edgar G. Haymond, Flint. (Resigned.)
*John Hazelwood, Port Huron.
U. P. Hedrick, B. S., Michigan Agricultural College. (Removed from State.)
GEORGE HEMPL, Ph. D., University of Michigan, Ann Arbor. (Resigned.)
E. M. Houghton, M. D., Detroit. (Resigned.)
BELA HUBBARD, Detroit. (Died June 13, 1896.)
*LUCIUS L. HUBBARD, Ph. D., Houghton.
Henry S. Hulbert, Detroit. (Resigned.)
*Frederick C. Irwin, Bay City.
William Jackman, Iron Mountain. (Resigned.)
STILLMAN G. JENKS, Kalamazoo College, Kalamazoo. (Resigned.)
LORENZO N. JOHNSON, University of Michigan, Ann Arbor. (Deceased.)
*JOHN B. JOHNSTON, University of Michigan, Ann Arbor.

*FRANCIS W. KELSEY, Ph. D., University of Michigan, Ann Arbor.
CHARLES A. KOFOID, Ph. D., University of Michigan. (Removed from State.)
*CLARENCE H. LANDER, University of Michigan, Ann Arbor.
*ALFRED C. LANE, Ph. D., Lansing.
*Harry L. Lewis, 510 Hillsdale St., Lansing.
WARREN H. LEWIS, Ann Arbor. (Resigned.)
FRANK R. LILLIE, Ph. D., University of Michigan, Ann Arbor. (Removed from State.)
*WARREN P. LOMBARD, M. D., University of Michigan, Ann Arbor.
*Burton O. Longyear, Michigan Agricultural College, Agricultural College P. O.
*Albert B. Lyons, M. D., Detroit.
*J. G. McClymonds, M. D., Ann Arbor.
*C. D. McLOUTH, 230 Sanford St., Muskegon.
*M. J. Magee, Sault Ste. Marie.
*W. P. MANTON, M. D., 32 Adams Ave., Detroit.
*Charles E. Marshall, Ph. B., Michigan Agricultural College, Agricultural College P. O.
*Asa E. Mattice, Concord.
MANLY MILES, M. D., Lansing. (Died Feb. 15, 1898.)
*John M. Millar, Escanaba.
*Miss Louise Miller, Detroit.
J. MONTGOMERY, Ann Arbor. (Resigned.)
*Robert E. Morrell, Escanaba.
Willard E. Mulliken, 191 First Ave., Grand Rapids. (Resigned.)
*WILLIAM H. MUNSON, B. S., Hillsdale College, Hillsdale.
*FREDERICK C. NEWCOMBE, Ph. D., University of Michigan, Ann Arbor.
*Jason E. Nichols, Lansing.
*FREDERICK G. NOVY, M. D., University of Michigan, Ann Arbor.
*W. A. Oldfield, Port Sanilac.
MRS. LUCY A. OSBAND, Ypsilanti. (Resigned.)
*Chase S. Osborn, Sault Ste. Marie.
*Edith Ellen Pettee, 83 Harper Ave., Detroit.
*WILLIAM H. PETTEE, A. M., University of Michigan, Ann Arbor.
*Rufus H. Pettit, B. S. A., Michigan Agricultural College, Agricultural College P. O.
*Jessie Phelps, State Normal, Ypsilanti.
Willard S. Pope, Detroit. (Died Oct. 10, 1895.)
HOYT POST, Michigan Fish Commission, Detroit. (Resigned.)
*Albert B. Prescott, M. D., LL. D., University of Michigan, Ann Arbor.
*Miss Harriett Putnam, 900 Congress Ave., Saginaw.
*Orlan B. Read, Hillsdale College, Hillsdale.
*JACOB REIGHARD, Ph. B., University of Michigan, Ann Arbor.
*ISRAEL C. RUSSELL, LLD., University of Michigan, Ann Arbor.
MRS. CYNTHIA SAGER, Ann Arbor.
*Herbert E. Sargent, Detroit.
JOHN H. SCHAFFNER, Ann Arbor. (Resigned.)
*Julius O. Schlotterbeck, Ph. D., University of Michigan, Ann Arbor.
*C. F. Schneider, Lansing.
*Miss Anna A. Schryver, State Normal, Ypsilanti.

LOUIS T. SCHURRER, Lakeport. (Resigned.)
*Karl Schwiekerrath, Ph. D., Parke Davis & Co., Detroit.
*A. E. Seaman, S. B., Michigan College of Mines, Houghton.
*Percy S. Selous, Greenville.
*JAMES B. SHEARER, Bay City.
*LOREN A. SHERMAN, Port Huron.
*WILLIAM H. SHERZER, M. S., State Normal, Ypsilanti.
EUGENE C. SKINNER, M. D., Detroit. (Died January, 1899.)
*Norman B. Sloan, Flint.
*CLINTON D. SMITH, M. S., Michigan Agricultural College, Agricultural College P. O.
*F. D. Smith, Greenville.
HARLAN I. SMITH, Saginaw, E. S. (Removed from State.)
*VOLNEY M. SPALDING, Ph. D., University of Michigan, Ann Arbor.
*Frederick W. Sperr, E. M., Michigan College of Mines, Houghton.
*MISS FRANCES L. STEARNS, Adrian College, Adrian.
JOSEPH B. STEERE, Ph. D., Ann Arbor. (Resigned.)
*Edward H. Stein, 255 12th Ave., Grand Rapids.
*Oliver Stewart, M. D., Port Huron.
Charles B. Stockwell, M. D., Port Huron. (Resigned.)
*Eugene Straight, Howard City.
*Louis H. Streng, 335 N. Prospect St., Grand Rapids.
*E. A. STRONG, A. M., State Normal, Ypsilanti.
George Sultie, M. D., Detroit. (Resigned.)
Calvin Thomas, University of Michigan, Ann Arbor. (Removed from State.)
*David Trine, B. S., Lansing.
*JEROME TROMBLEY, Petersburg.
*Victor C. Vaughan, M. D., Ph. D., University of Michigan, Ann Arbor.
*M. E. WADSWORTH, Ph. D., Michigan College of Mines, Houghton.
*BRYANT WALKER, 18 Moffat Block, Detroit.
HENRY B. WARD, Ph. D., Ann Arbor. (Removed from State.)
*Louis E. Warren, Hillsdale.
OSCAR B. WARREN, Palmer. (Removed from State.)
*George A. Waterman, V. S., Michigan Agricultural College, Agricultural College P. O.
*L. WHITNEY WATKINS, B. S., Manchester.
MARGARET WEIDEMANN, Ann Arbor. (Removed from State.)
*CHARLES F. WHEELER, M. S., Michigan Agricultural College, Agricultural College P. O.
*E. S. WHEELER, Sault Ste. Marie.
*Alfred H. White, A. B., University of Michigan, Ann Arbor.
*CHARLES A. WHITTEMORE, 656 Madison Ave., Grand Rapids.
*Cressy L. Wilbur, M. D., Department of State, Lansing.
George E. Willetts, Lansing. (Resigned.)
*MRS. E. G. WILLOUGHBY, Ann Arbor.
*MORTIMER WILSON, M. D., 6th and Water Sts., Port Huron.
ROBERT H. WOLCOTT, M. D., Grand Rapids. (Removed from State.
FRANK E. WOOD, Bay City. (Removed from State.)
*Norman A. Wood, 19 Church St., Ann Arbor.

*Philip B. Woodworth, B. S., Michigan Agricultural College, Agricultural College P. O.
*DEAN C. WORCESTER, A. B., University of Michigan, Ann Arbor.

## CORRESPONDING MEMBERS.

Howard B. Baker, M. D., 223 E. 48th St., New York, N. Y.
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Charles A. Kofoid, Ph. D., University of Illinois, Champaign, Ill.
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