PROCEEDINGS

of the

Ohio State Academy of Science

VOLUME IV, PART 1.

Twelfth Annual Report.

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume IV, Part I.

Twelfth Annual Report

OF THE

OHIO STATE ACADEMY OF SCIENCE

1903.

ORGANIZED 1891. INCORPORATED 1892.

PUBLICATION COMMITTEE:

J. H. SCHAFFNER. JAS. S. HINE. GERARD FOWKE.

DATE OF PUBLICATION, April 15th, 1904.

PUBLISHED BY THE ACADEMY
COLUMBUS, OHIO.

OFFICERS.—1904.

PRESIDENT.

E. L. MOSELEY.

VICE-PRESIDENTS.

LYNDS JONES, L. H. McFADDEN.

SECRETARY.

F. L. LANDACRE.

TREASURER.

HERBERT OSBORN.

LIBRARIAN.

W. C. MILLS.

EXECUTIVE COMMITTEE.

Ex-Officio.

E. L. MOSELEY, HERBERT OSBORN, F. L. LANDACRE.

Elective.

W. E. WELLS, W. F. MERCER.

BOARD OF TRUSTEES.

W. R. Lazenby, Chairman, term expires 1906
F. M. Webster, term expires 1904
J. H. Schaffner, term expires 1905

PUBLICATION COMMITTEE.

J. H. Schaffner, Chairman, term expires 1905
Gerard Fowke, term expires 1904
Jas. S. Hine, term expires 1906

PAST OFFICERS.

PRESIDENTS.

1892. E. W. Claypole,
1893. Edward Orton,
1894. F. M. Webster,
1895. D. S. Kellicott,
1896. A. A. Wright,
1897. W. A. Kellerman,
1898. W. G. Tight,
1899. G. F. Wright,
1900. Josua Lindahl,
1901. A. D. Selby,
1902. W. R. Lazenby,
1903. C. J. Herrick.

VICE-PRESIDENTS.

1892. A. A. Wright, Ellen E. Smith.
1893. D. S. Kellicott, D. L. James.
1894. G. H. Colton, Mrs. W. A. Kellerman.
1895. H. E. Chapin, Jane F. Winn.
1896. A. L. Treadwell, Chas. Dury.
1897. C. E. Slocum, J. B. Wright.
1898. Josua Lindahl, J. H. Todd.
1899. Chas. E. Albright, A. D. Selby.
1900. J. A. Bownocker, Lynds Jones.
1901. H. Herzer, Mrs. W. A. Kellerman.
1902. C. J. Herrick, C. S. Prosser.
1903. J. A. Bownocker, Miss L. C. Riddle.

TREASURERS.

1892-95. A. D. Selby,
1896-98. D. S. Kellicott,
1899-03. Herbert Osborn.

SECRETARIES.

1892. W. R. Lazenby,
1893-94. W. G. Tight,
1895-03. E. L. Moseley.

TRUSTEES.

1900-03. F. M. Webster,
1900-02. H. C. Beardslee,
1900 03. J. H. Schaffner,
1901-03. W. R. Lazenby.

PUBLICATION COMMITTEE.

1892-01. F. M. Webster,
1892-97. W. A. Kellerman,
1892-96. E. W. Claypole,
1897-99. E. L. Moseley,
1898-00. S. Belle Craver,
1900-03. J. H. Schaffner,
1901-03. L. H. McFadden,
1902-03. Gerard Fowke.

MEMBERSHIP, February 15th, 1904.

LIFE MEMBER.

McMillin, Emerson E. .... 40 Wall St., New York

ACTIVE MEMBERS.

Aiken, Walter H., Bot., Station K, Cincinnati
Albright, Charles E., Columbus
Armstrong, C. A., Geol., Canton
Ball, E. D., Ent., Logan, Utah
Baird, R. L., Zool., Geol., Oberlin
Barnard, B. C., Beaver Falls, Pa.
Berger, E. W., Berea
Blair, Kate R., Biol., 1457 Neil Ave., Columbus
Black, J. C., Wooster
Bonser, T. A., Bot., Geol., 0625 Superior Ave., Spokane, Wash.
Baur, Lizzie E., Bot., Zool., Geol., Phys., Geog., Canton
Bownocker, John A., Geol., O. S. U., Columbus
Bridwell, John C., Ent., Bot., Durham, N. H.
Brigham, F. M., 2712 Monroe St., Toledo
Britton, J. C., Ent., Dept. Ag., Washington, D. C.
Brockett, Ruth E., Bot., Rio Grande
Brugger, Harvey, Bot., Clyde
Bubna, Matthias, Ent., 9 Heina St., Cleveland
Burgess, A. F., Ent., 1576 Neil Ave., Columbus
Burr, Harriet G., Bot., Worthington
Carter, Chas., Ent., Corydon, Iowa
Claassen, Edo, Bot., 429 Woodland Ave., Cleveland
Clark, W. B. Granville
Coberly, Edward D., Bot., O. S. U., Columbus
Collett, S. W., Bot., Toledo, Iowa
Colton, George H., Hiram
Comstock, Frank M., Vert. Zool., Case School, Cleveland
Cookson, Charles W., Geol., Somerset
Copeland, W. F., Athens
Corson, H. C., Akron
Davis, V. H., Hort., O. S. U., Columbus
Dawson, W. Leon., Ornith., 49 Chittenden Ave., Columbus
Detmers, Freda, Bot., 1315 Neil Ave., Columbus
Dunlap, Fred, Forestry, 135 Blair St., Ithaca, N. Y
Dury, Chas., 524 Ridgway Ave., Cincinnati
Dutton, C. F., Jr., 64 W. Roy Ave., Cleveland
Duvel, J. W. T., Bot., Washington, D. C., Div. of Bot
Edwards, E. H., Zool., Physiol., 259 W. Clinton St., Cleveland
Feiel, Adolph, 520 E. Main St., Columbus
Field, Irving A., Biol., 61 Oxford St., Cambridge, Mass.
Fischer, Walter, Bot., Miami, Fla.
Flynn, Maud, Zool., Columbus
Foulk, C. W., Chem., O. S. U., Columbus
Fowke, Gerard, Glac. Geol., Arch., Chillicothe
Frank, J. N., Bot., Ent., O. S. U., Columbus
Gary, L. B., Geol., Austinburg
Gill, George W., Geol., 380 E. Broad St., Columbus
Grover, F. O., Bot., Oberlin
Griggs, R. F., Bot., 1318 Forsythe Ave., Columbus
Hambleton, J. C., Bot., Zool., 212 E. Eleventh Ave., Columbus
Harry, Scott G., Ornith., North Buckeye St., Wooster
Hartzell, J. C., Bloomington, Ill.
Harvey, Ruth S., Ornith., Bond Hill
Harvey, Gertrude F., Ornith., Bond Hill
Hayes, Seth, Lancaster
Herms, W. B., German Wallace College, Berea

Herrick, C. Judson, Granville
Herzer, H., Paleon., Marietta
Hillig, Fred J.,
St. John's College, Toledo
Hine, J. S., Ent., Ornith.,
O. S. U., Columbus
Hobbs, P. L., Chem., Cleveland
Holt, W. P., Bot., Toledo
Hopkins, A. D., Ent.,
Morgantown, W. Va.
Hopkins, L. S., Geol., Troy
Houk, Eliza P. T., Chem.,
Dayton
Hunt, Thomas F., Ag.,
Ithaca, N. Y.
James, Davis, L.,
127 W. Seventh St., Cincinnati
Janney, John J., Hort.,
93 Fifteenth Ave., Columbus
Jennings, O. E., Bot.,
Carnegie Museum, Pittsburg, Pa.
Jones, Lynds, Ornith.,
College Museum, Oberlin
Judson, C. A., Bot.,
235 Columbus Ave., Sandusky
Keeler, Miss H. L., Bot.,
93 Olive St., Cleveland
Kellerman, William A., Bot.,
175 W. Eleventh Ave.,Columbus
Kellerman, Mrs. W. A., Bot.,
175 W. Eleventh Ave.,Columbus
Kelsey, F. D., Bot.,
2146 Fulton St., Toledo
Kiefer, R. J., Attica
Kline, W. A., Biol., Westerville
Landacre, F. L., Zool.,
O. S. U., Columbus
Lazenby, Wm. R., Hort., Bot.,
O. S. U., Columbus
Lindahl, Josua, Zool.,
312 Broadway, Cincinnati
Lloyd, John Uri,
Court and Plum Sts., Cincinnati
Louth, E. V., Bot., Ashtabula
Luke, Fred K., Bot., Hort.,
Mo. Bot. Garden, St. Louis
Mally, C. W., Ent.,
Grahamstown, South Africa
Mally, Mrs. C. W.,
Grahamstown, South Africa
Masterman, E. E., Zool, Bot.,
New London
Mateer, H. N., Biol., Wooster
Mathews, Mary E., Painesville
McCoy, C. T., Bot.,
317 E. Mulberry St., Lancaster
McElhinny, Frank B., Bot.,
New London
McFadden, L. H., Chem.,
Westerville
MacKinnon, J. A., Ornith.,
Grand Ave., Toledo
Mead, Chas. S., Zool., Bot.,
217 King Ave., Columbus
Mercer, W. F., Biol.,
Ohio University, Athens
Metcalf, Zeno P., Plympton
Mills, W. C., Arch., Biol.,
O. S. U., Columbus
Moorehead, Warren K., Arch.,
Andover, Mass.
Morse, Max W., Zool.,
O. S. U., Columbus
Moseley, E. L., Zool., Bot.,
Physiog., Sandusky
Nelles, Geo. T., U. S. Eng.,
Of. Hickox Bldg., Cleveland
Newell, Wilmon, Ent.,
Atlanta, Ga.
Oberholser, H. C.,
1454 Sheridan Ave., N. W.,
Washington, D. C.
Odenbach, F. L., Meteor.,
St. Ignatius Coll., Cleveland
Osborn, Herbert, Ent., Zool.,
O. S. U., Columbus
Osburn, Raymond C., Zool., Ichth.,
510 W. 124th St., New York
Outhwaite, Joseph H.,
U. S. Ordnance, Columbus
Oviatt, H. L., Gen. Sci., Norwalk
Pallister, H. D.,
1138 Independence St., Cleveland
Parrott, P. J., Ent., Geneva, N. Y.
Peck, J. E., Geol., Delaware
Peppel, S. V., Chem., Geol., Surv.,
Columbus
Piwanka, Thomas,
243 Superior St., Cleveland
Prosser, C. S., Geol.,
O. S. U., Columbus
Rhoades, W. R.,
Gas Works, Springfield, Ill.
Rice, Edward L., Zool.,
Delaware
Riddle, Lumina C., Bot.,
O. S. U., Columbus
Roudebush, Lowell, Owensville
Royer, John S., Biol.,
247 N. Seventeenth St., Columbus
Sanders, J. G., Ent., Bot.,
Westerville

Sanger, U. G., Bot., St. Mary's
Schaal, William G., Berea
Schaffner, John H., Bot., O. S. U., Columbus
Scott, Daisy M., 1274 Summit St., Columbus
Seaton, Miss F., 103 Glen Park Place, Cleveland
Selby, A. D., Bot., Experiment Sta., Wooster
Simkins, J. D., Gla. Geol., St. Marys
Slocum, Mrs. Belle, Wayne Bldg., Toledo
Slocum, C. E., Defiance
Smith, Miss I. S., Bot., Oberlin
Smith, J. Warren, Meteor., Columbus
Snyder, F. D., Zool., Ethnol., Ashtabula
Soule, William, 1804 S. Union Ave., Alliance
Stair, L. D., 1062 Madison St., Cleveland
Sterki, Victor, Conch., Bot., New Philadelphia
Stickney, M. E., Bot., Granville
Stockberger, W. W., Bot., Dept. Agr., Washington, D. C.
Stoner, Minnie A., Dom. Sci., O. U. S., Columbus
Storke, Sophia D., 1040 Franklin Ave., Cleveland
Surface, F. M., Zool., Bot., Eaton
Sutton, J. G., Physics, Geol., Rushsylvania
Sweezey, Otto H., Board of Agr., Columbus
Thompson, Mrs. King, 167 W. Tenth Ave., Columbus
Tillman, Miss Opal I., O. S. U., Columbus
Tight, W. G., Geol., Albuquerque, N. M.
Todd, Joseph H., Geol., Arch., Christmas Knoll, Wooster
True, H. L., McConnelsville
Tussing, P. I., Geol., Ada
Tyler, F. J., Bot., Plant House., Div. of Bot., Washington, D. C.
Walton, L. B., Biol., Gambier
Webb, R. J., Bot., Garrettsville
Webster, F. M., Ent., Urbana, Ill.
Wells, W. E., Biol., Antioch Coll., Yellow Springs
Werthner, William, Bot., Steele High School, Dayton
Westgate, Lewis G., Geol., Delaware
Wetzstein, A., Bot., St. Marys
Whetsel, J. A. G., Bot., Zool., South New Lyme
Whitney, W. C., Biol., Geol., Westerville
Williams, Stephen R., Biol., Miami Univer., Oxford
Williamson, E. Bruce, Ichth., Ornith., Bluffton, Ind.
Wilson, Miss S. S., Geol., Phys. Geog., 97 N. 20th St., Columbus
Wilkinson, E., Bot., Mansfield
Wolfe, E. E., Bot., Marietta Coll., Marietta
Wright, G. Frederick, Geol., Oberlin
Wright, Albert A., Geol., 123 Forest St., Oberlin
York, Harlan H., Bot., O. S. U., Columbus

Report of the Thirteenth Annual Meeting

OF THE

Ohio State Academy of Science.

ANNUAL MEETING.

The thirteenth annual meeting of the Academy was held at Denison University, Granville, November 27, 1903. All but one of the papers on the printed program were read.

Regarding the status of membership, the secretary reported that the executive committee had decided, "the Academy is so small as to make any classification of members unnecessary."

In accordance with a recommendation of the treasurer, the Academy decided that "authority shall be secured from the executive committee before any debt is incurred by any member, officer, or committee."

Hereafter members are not to receive the publications if their dues are in arrears more than one year.

The publication committee reported: "During the year four reports have been published, amounting in all to 435 pages. The greater part of the expense of publication was covered by the McMillin fund."

The trustees reported: "During the year the Academy has published three valuable 'Special Papers,' Nos. 5, 6 and 7. The studies upon which these papers were based were largely carried on by aid from the Emerson McMillin Research fund, and the expense of publication was mainly met by the further aid of the same fund. It is expected that two more 'Special Papers' will be completed and published during the year 1904, and that in addition to this, much research work in other lines will be done. The annual donation of $250.00 by Emerson McMillin for the year 1904 has been received and deposited in the Capital City Bank, Columbus."

The Academy adopted the following resolutions:

FIRST.

"*Resolved,* That the rule be established that no paper shall hereafter be admitted to the program of the annual meeting, unless by special vote of the Academy, which shall not have been submitted either in full or in abstract to the program committee and approved by them. Titles of proposed papers may be sent to the program committee or to the secretary at any time in advance of the meeting in order to aid the committee in planning the program, but this cannot take the place of the absract. Abstracts should not exceed 300 words in length and should be submitted typewritten in the form desired for publication in the proceedings. The full text of all papers designed for publication by the Academy, properly edited for publication and typewritten, should be in the hands of the publication committee not later than the adjournment of the annual meeting."

SECOND,

"*Resolved*, That the Ohio Naturalist be made an official organ of the Ohio State Academy of Science, the Naturalist to print in full papers under 1,500 words in length, and abstracts, not to exceed 300 words in length, of other papers read. All abstracts and other MSS. designed for the Ohio Naturalist, after having been passed upon by the publication committee, shall be submitted in typewritten form to the editor of the Ohio Naturalist within one week after the adjournment of the annual meeting.

"The Ohio Naturalist shall publish announcements of meetings, lists of publications for sale, etc., whenever the Academy may desire, such announcements not to exceed one-half page of advertising matter in any one issue. Copies of all numbers of the Ohio Naturalist shall be sent to all members of the Academy not in arrears for the payment of dues.

"The Academy shall pay to the Ohio Naturalist 50 cents for each subscription of the Naturalist thus sent to its members.

"The annual reports, including lists of members, officers, proceedings, the presidential address and such other matter as the publication committee may determine, shall be issued separately by the publication committee. Papers offered for publication which exceed 1,500 words in length may be published by the Academy, when accepted by the publication committee, in the series of Special Papers now running. The publication committee shall assemble the Annual Reports and Special Papers into volumes of proceedings of convenient size and page them consecutively in each volume. But a part of the edition of each volume of proceedings shall be made up with each Annual Report and Special Papers stitched and covered separately, and offered for sale at the lowest reasonable rate."

PAPERS READ.

1. Preliminary Report on the Development of the Gill in Mytilus ....Edward L. Rice
2. Comparative Chart of the Vertebrate Skull.......Charles S. Mead
3. The Protozoa of Sandusky Bay ....F. L. Landacre
4. A New Peritrichous Infusorian ....F. L. Landacre
5. Report on the Reptiles and Batrachians of Ohio........Max Morse
6. The Protozoa of Brush Lake ....Lumina C. Riddle
7. Cataloguing Museum Collections ....L. B. Walton
8. A Practical Dissecting Tray ....L. B. Walton
9. A Further Contribution to the Hemipterous Fauna of Ohio.. ....Herbert Osborn
10. Report on the Scale Insects of Ohio ....J. G. Sanders
11. Report on the Orthoptera of Ohio ....Chas. S. Mead
12. A Supplement to the Odonata of Ohio ....James S. Hine
13. Notes on the Introduction of the Chinese Ladybird, Chilocorus similis, in Ohio ....A. F. Burgess
14. Notes on a Macropterous Phylloscelis atra........Herbert Osborn
15. The Breeding Habits of the Myriopod, Fontaria Indianae Boll ....Max Morse
16. A Statistical Plea for Nature Study ....Edward L. Rice
17. Shore Line Topography between Toledo and Huron, Ohio—Lantern Slides ....Lewis G. Westgate
18. Some Rare Forms of Aboriginal Implements ....J. H. Todd
19. List of the Mosses of Cuyahoga and Other Counties of Northern Ohio ....Edo Claassen
20. Extra-Floral Nectaries and Other Glands........John H. Schaffner
21. Notes on Nutating Plants ....John H. Schaffner
22. Notes on Some Rare and Interesting Ohio Plants..Otto E. Jennings
23. The Keeping Qualities of Apples ....Wm. R. Lazenby
24. Seeds of Celastraceæ ....Wm. R. Lazenby
25. Variation and Environment ....L. B. Walton
26. Further Floristic Studies in West Virginia ......W. A. Kellerman
27. Additional Infection Experiments with Species of Rusts...... ....W. A. Kellerman
28. Mycological Flora of Cedar Point, Sandusky, Ohio—Abstract ....W. A. Kellerman
29. Group Names in Natural History ....W. A. Kellerman
30. Historical Account of Uredineous Culture Experiments, with List of Species—Abstract ....W. A. Kellerman
31. Annual Report on the State Herbarium ....W. A. Kellerman and O. E. Jennings
32. On the Occurrence of Fossombronia cristula in Ohio..Edo Claassen
33. The Agar-agar Method of Imbedding Plant Tissues.......... ....Harlan H. York
34. Report on the Flowering Plants and Ferns of Cedar Point.... ....Otto Jennings
35. Preliminary Report on the Geology and Ecology of Clifton Gorge ....W. E. Wells
36. Notes on the Aradidæ of Ohio....................Herbert Osborn
37. A Root-Infesting Fulgorid ....Herbert Osborn

E. L. Moseley, Secretary.

NOTICE IN REGARD TO PUBLICATIONS.

Since by a special resolution of the Academy, the Annual Reports and Special Papers are in the future to be collected into definite volumes consecutively paged, it becomes necessary to make some disposition of the reports already issued. It is very unfortunate that a definite and suitable plan of publication was not adopted by the Academy from the very beginning. But although there will be some inconvenience in having volumes consisting of reports specially paged, there seemed to be but one feasible plan, which is to collect the old reports into a number of volumes, each consisting of a number of parts. The reports are therefore collected into three volumes and the new plan with consecutive pagination thus begins with Volume IV. The disposition of the past reports is as follows:

Proceedings of the Ohio State Academy of Science, Vol. I, consists of the following Reports:

Part 1. Constitution, By-Laws, Officers, List of Members, and Historical Sketch; 1891. (Date of publicatlon, 1892.)

Part 2. First Annual Report of the Ohio State Academy of Science; 1892. (No date of publication.)

Part 3. Second Annual Report of the Ohio State Academy of Science; 1893. (No date of publication.)

Part 4. Third Annual Report of the Ohio State Academy of Science; 1894. (No. date of publication.)

Part 5. Fourth Annual Report of the Ohio State Academy of Science; 1895. (No date of publication.)

Part 6. Fifth Annual Report of the Ohio State Academy of Science; 1896. (Date of publication, 1897.)

Part 7. Sixth Annual Report of the Ohio State Academy of Science; 1897. (Date of pubilcation, 1898.)

Proceedings of the Ohio State Academy of Science, Vol. II, consists of the following Reports:

Part 1. Seventh Annual Report of the Ohio State Academy of Science; 1898. (Date of publication, 1899.)

Part 2. Special Papers No. 1, "Sandusky Flora." (Date of publication, May, 1899.)

Part 3. Special Papers No. 2, "The Odonata of Ohio." (Date of publication, March, 1899.)

Part 4. Eighth Annual Report of the Ohio State Academy of Science; 1899. (Date of publication, 1900.)

Part 5. Special Papers No. 3, "The Preglacial Drainage of Ohio." (Date of publication, December, 1900.)

Proceedings of the Ohio State Academy of Science, Vol. III, consists of the following Reports:

Part 1. Ninth Annual Report of the Ohio State Academy of Science; 1900. (Date of publication, 1901.)

Part 2. Special Papers No. 4, "The Fishes of Ohio." (Date of publication, May, 1901.)

Part 3. Tenth Annual Report of the Ohio State Academy of Science; 1901. (Date of publication, 1902.)

Part 4. Eleventh Annual Report of the Ohio State Academy of Science, 1902. (Date of publication, May 1, 1903.)

Part 5. Special Papers No. 5, "Tabanidæ of Ohio." (Date of publication, May 1, 1903.)

Part 6. Special Papers No. 6, "The Birds of Ohio." (Date of publication, October 15, 1903.)

Part 7. Special Papers No. 7, "Ecological Study of Big Spring Prairie." (Date of publication, 1903.)

It is the intention of the publication committee to publish title pages and indexes to the volumes as opportunity and funds will permit. As stated, Vol. IV will be paged consecutively; and hereafter there will be no difficulty in having the reports properly bound or in referring to articles contained in them.

JOHN H. SCHAFFNER.

PRESIDENT'S ADDRESS.

THE DOCTRINE OF NERVE COMPONENTS AND SOME OF ITS APPLICATIONS.

By C. Judson Herrick.

The original purpose of the students of nerve components was the analysis of the peripheral nervous system into units which should have at the same time a functional and a structural significance. This obviously is not the case with the cranial and spinal nerves as commonly enumerated. The structural peculiarities of each of the twelve pairs of cranial nerves, for instance, while fairly well defined in the human body, are very diverse in the vertebrate series as a whole. Thus the facial nerve from being predominantly sensory in lower vertebrates (more than half of its fibers in fishes belonging to a sensory system not represented at all in mammals) becomes in man predominantly motor with only a vestigeal remnant of the sensory components, and even the motor component innervates chiefly muscles new to the mammalia. We might multiply illustrations of the structural instability of the cranial nerves. And that the cranial nerves have any special significance as functional units cannot be maintained for a moment, no two pairs in the human body having even approximately the same function.

But the first measurably complete analysis of the cranial nerves into their components for their entire extent showed at once the presence of certain structural and functional systems of components, the laws of whose distribution have apparently little to do with the serial order of the cranial nerves as commonly enumerated.

We have, then, a number of systems of components each of which is defined structurally by similarity of peripheral and central terminal relations, and functionally by the transmission of nervous impulses of the same type or modality. Among these systems are tactile, auditory, visual, olfactory, motor, gustatory, etc., each with very characteristic terminal relations.

Now, this structure is absolutely meaningless apart from its function. Let any one who doubts this spend a few months (as I have done) in trying to master and correlate the existing literature of the cranial nerves of vertebrates. Though these descriptions were for the most part written by famous masters of anatomical science, yet in their aggregate they present an indigestible mass of confused and meaningless detail, crude fact, well spiced with error, for the most part not worth the prodigeous labor of digging it out of the oblivion of classic tomes of by-gone anatomists.

I do not mean to imply that all the problems of cranial nerve morphology are now cleared up; but I do claim that there is no longer any necessity for the further accumulation of uncritical and meaningless fact in this field of research. We have already gone far enough to point the way toward certain lines of fruitful correlation. We can not only correlate structure with structure, but we can interpret structure by function and thus bring out a fuller meaning. We are at least coming into a realization of the fact that we cannot fully understand any structure until we know what it can do.

This point of view of course is not new, but as worked out practically in the peripheral nervous system it is exerting a clarifying influence upon our knowledge of the central system also. The present demand in cerebral anatomy is for conduction paths, for functional systems of neurones, and precise knowledge of the pathways between the brain and the periphery is the first step in such a central analysis.

The primary function of the nervous system is to facilitate the reaction of the organism to the external forces of the environment. Later, as the reacting mechanism becomes more complicated, the nervous system assumes the function of co-ordinating this mechanism, *i. e.*, of reaction to the forces of the internal environment. These two functions lie at the basis of our most fundamental division of the analysis of the nervous system, viz.: (1) the somatic systems (sensory and motor) for bodily responses to external stimuli, and (2) the visceral systems (sensory and motor) for visceral reactions to internal stimuli.

Each of these great divisions has been analyzed peripherally, more or less imperfectly as yet, into systems of components, as suggested above. Every such system of nerve fibers performs a separate function, conducts a single type of nervous impulse, either afferent, *i. e.*, sensory, or efferent, *i. e.*, excito-motor, excito-glandular, etc. The following systems are already distinguishable anatomically:

I. Somatic Systems.

1. *Tactile*, or *general Cutaneous.*
2. *Acustico-lateral,* including nerves for lateral line organs (in the Ichthyopsida) and for organs of equilibration and hearing (in vertebrates generally). These organs and their nerves have probably been derived phylogenetically from the general cutaneous system and, like the organs of the latter type, are adapted for the reception of various kinds of mechanical impact, either rhythmic or non-rhythmic.
3. *Visual* (a system of uncertain relationship, provisionally classified under the somatic sensory).
4. *Somatic motor,* for the innervation of skeletal or voluntary muscles.

II. Visceral Systems.

5. *Visceral sensory*, unspecialized sensory nerves of the viscera, distributed chiefly through the sympathetic nerves.
6. *Gustatory,* innervating specialized sense organs (taste buds) of chemical sense, probably derived phylogenetically from the preceding type.
7. *Olfactory* (provisionally classified here because of the apparent resemblance betwen taste and smell).
8. *Visceral motor,* distributed chiefly to unstriped and involuntary muscles, generally through the sympathetic system.
9. *Excito-glandular,* provisionally classified here because of general resemblance to the last mentioned type.

There are numerous other systems which can be differentiated physiologically, but which cannot as yet be completely separated anatomically and classified, such as nerves for the thermal sensations, muscle sensations, etc., but enough has been done to enable us to lay down the general plan or pattern of the peripheral nervous system as a whole and to define the main pathways by which stimuli of different modalities reach the brain and are reflected back to the responsive organs. Our anatomical knowledge of these pathways is sufficiently well controlled by precise physiological experimentation to enable us to state with confidence that each of the nine systems mentioned above is a real functional unit.

The fibers composing these systems may reach the central nervous system through a series of many nerve roots arranged in a segmental way, like the general cutaneous nerves of the spinal cord, or they may all be represented in a single large nerve, like the optic and olfactory. Thus it happens that some nerves, like those last mentioned, are "pure" nerves, while others, like the facialis or vagus, are "mixed," containing in some cases as many as four anatomically distinguishable components.

It is a general rule that in the body the components tend to be distributed among a large number of nerves in a more or less segmental way, while in the head they tend to be concentrated into a few pathways, or only one, into the brain, an adaptation which presents obvious advantages for the simplification and unification of the secondary reflex paths from these primary centers.

Now, the central nervous system is, as we have already seen, primarily a mechanism to facilitate the reaction of the animal to impressions from without, in other words, to put the body in correspondence with the environment. Its structure is directly determined by the avenues of sense through which these stimuli come in and by the character of the responses to these stimuli which are necessary for the conservation of the organism. In view of the fact that we already possess a detailed knowledge of these peripheral nervous pathways, it is manifest that we have here a most favorable avenue of approach in an analysis of the inconceivable complexity of cerebral structure.

We must know in detail the possible reflex pathways in the brain for all olfactory, visual, gustatory responses, etc., in the vertebrate type, and then on the basis of such a functional subdivision of the brain the problem of the mechanisms of higher cerebral processes may be attacked with a reasonable hope of success. The investigation of the internal organization of the brain may be pursued in several ways:

I. The direct study of the human brain, both normal and pathological. On account of the enormous practical importance of neurology to both human psychology and pathology, research naturally turned directly to the human brain; but a more unfavorable starting point could not be found.

II. It is now generally recognized that the complex human brain can best be understood by finding first a simpler pattern such as is presented by one of the lowest vertebrates. Accordingly the phyletic method has dominated all recent neurological research. The brains of individual species are studied and monographed, particular attention being paid to the lower members of the vertebrate series in the hope of finding in them a schema or paradigm which can be followed upward through the comparative anatomical series and, after comparison with the ontogeny of higher brains, lead to a reconstruction of the phylogenetic history of the brain. While this method has been of great service, especially to such problems as can be approached from the study of external morphology, it is immensely difficult when applied to the histological problems, and as a matter of fact has not as yet taken us very far.

III. A third method, instead of taking an entire brain as the unit of research, concentrates attention upon a single functional system and seeks to get exhaustive comparative knowledge of it in many types. Starting with a fairly accurate and detailed knowledge of the functional systems at the periphery, we have simply to extend the lines of inquiry here blocked out for us.

This gives a type of problem which is much more approachable than the others. It is not so complex, but more intensive. Of still more importance are the facts that the anatomical data can be directly correlated by physiological experimentation, and the method is open to experimental control all along the line. Our degeneration methods open up possibilities here which are incomparably more valuable than the most precise anatomical observation.

And nature has performed for us a series of experiments which are in a sense the converse of our degeneration methods. The various sensori-motor systems are very unequally developed, some animals possessing one in a high state of elaboration, some another. If therefore we begin our studies on the visual system for instance, with animals such as most birds with very highly developed eyes, and then compare with animals with vestigeal eyes, it is evident that we have here a means of isolating the system for scientific study which has some points of superiority over artificial experimental methods. Fortunately within the group of fishes, whose brains are all constructed on a plan fundamentally similar, we have the most remarkable diversity in the degree of development of the several systems, so that this is a favorable starting point for this method, especially since the brain is composed almost wholly of the simpler reflex mechanisms without the complications which we find in mammals due to the enormous developments of higher associational centers in the forebrain. Some fishes have huge eyes, some are blind; some have elaborate olfactory apparatus, some very slight; some show a marvelous hypertrophy of the organs of taste, or touch, etc. These organs are all open to physiological study and so the functions can be accurately determined. Then, having found the cerebral pathways for each system where it reaches its maximum development, we can more easily trace out the system in other types, and thus arrive ultimately at a full knowledge of its evolutionary history.

All scientific method is both analytic and synthetic. In the phyletic type of neurological method, these two processes are apt to be far separated and the observed facts may remain inert and relatively meaningless, because imperfectly understood, incoordinated. In our third type of method, on the other hand, it is easier to correlate the data as we go along, the synthesis accompanies the analysis, and the possibility of experimental control should keep the student in closer touch with his guiding facts and discourage general speculation.

As a concrete illustration of the practical method of applying the doctrine of nerve components in the functional analysis of the nervous system, we may summarize briefly the progress which has been made up to date in the study of the gustatory system.

In man, as is well known, the sense of taste is not very highly developed. The peripheral organs, or taste buds, are situated chiefly on the tongue, those near its base innervated by the glossopharyngeal nerve, and those near the tip probably by the chorda tympani of the facial nerve. But the gustatory pathway toward the brain is very imperfectly understood and many points are still in controversy, while the central path is almost wholly unknown.

But in certain fishes, such as the carp and cat fish, this system of sense organs is enormously exaggerated. Taste buds are found, not only in the mouth, but all over the outer skin and barblets. Direct experiment shows that these fishes actually do taste with these superficial sense organs—unlike some people, their taste is not all in their mouth.

The experiments made on the cat fish (Ameiurus) show that these fishes seek their food by feeling for it with the barblets and by means of them they discriminate between edible and non-edible substances, that they habitually use both the sense of touch and the sense of taste for the purpose and that they can be taught to discriminate between tactile and gustatory stimuli applied to the skin and will turn and snap up savory substances and reject objects which feel like them but are devoid of taste.

The exact distribution of the gustatory sense organs has been determined and their nerves traced back to the brain. We get the gustatory reaction from the skin as described above in fishes which possess these cutaneous sense organs, and the reaction is not obtained from fishes which do not possess such sense organs and nerves.

All of these cutaneous sense organs are innervated from a single nerve, the sensory root of the facial (corresponding to the portio intermedia of human anatomy), which is the biggest nerve in the body. The center in which this nerve terminates in the medulla oblongata is about as big as the entire forebrain.

instead of being barely discernable by refined histological methods, as in the human body. And the secondary gustatory path, which in man is totally unknown, is the largest single tract in the brain, both in the cat fish and in the carp!

The primary gustatory center in the medulla oblongata is bilobed, the "facial lobe," receiving the gustatory fibers from the skin and the "vagal lobe" receiving those from the mouth. From these lobes there is both an ascending and a descending gustatory path. The latter passes down to the point where the medulla oblongata merges into the spinal cord and there terminates in a special nucleus which is intimately related to the funicular nuclei, a center for tactile sensations. Here the tactile and gustatory stimuli are co-ordinated and a common descending bundle (tertiary path) passes back into the spinal cord for the body movements necessary to turn toward the food object. The ascending secondary gustatory path extends upward to a big nucleus under the cerebellum, from which tertiary pathways extend forward and downward into the midbrain (chiefly in the inferior lobe), then backward by a descending path of the fourth order into the medulla oblongata to reach the motor nuclei of the cranial nerves.

We have already gone far enough into our analysis of these secondary and tertiary gustatory paths to make it perfectly safe to predict that all of the habitual gustatory reflexes which we have observed in these fishes can be followed anatomically through the brain for their entire extent. And since we have the strongest reasons for believing that the elementary reflex paths are essentially similar in mammals and fishes, we expect to find here an important guide for further research in human anatomy.

So the other sensori-motor systems may be severally investigated, beginning the attack in each case with some species low down in the vertebrate series in which this particular mechanism is highly developed, and then extending the research to higher and lower types.

We may ultimately hope for a subdivision of the brain which shall be both structural and functional, each organ or pathway being given its function or meaning in the system as a part of the machinery of keeping the body in vital, helpful contact with environing forces. The great morphological "head problems," such as the primitive metamerism and the subsequent marvelous kalaidoscopic changes in structure and function of the component segments, these must all be read through the medium of such an intensive study of these factors upon which all differentiation has in last analysis depended.

There is another point of view from which I have been somewhat interested to develop the implications of the doctrine of nerve components, that of scientific methology in general.

It is said that scientific explanation consists essentially in such an organization of facts that they may be generalized or included under certain laws or uniformities which permit a forecasting of future events. Now, without going into an exposition at this time of the implied philosophy of nature, I think that a little reflection will show that this statement, while true in a certain limited sense, is very defective.

What is the nature of this organization of facts from which so great benefits are expected to flow? Can it in last analysis be anything other than the correlation of experience? All of the "facts" with which we deal have grown up in experience; they are in a literal sense the products of our experience. As men of science we have nothing to do with "things-in-themselves," only with phenomena, out of which we have constructed by mental process certain objective things which we regard as real—"constructs," or in common parlance, objects, facts, data.

By these things which grew up in experience (we have in most cases forgotten how) we measure up and evaluate all new experience. If the new sense presentation is a yellow dog with white feet we assimilate it at once with previous experience and approve it as a valid fact. If, on the other hand, it is a green dog with thirteen scarlet heads each with a forked tongue, we are apt to ask, Am I awake or asleep? or, What was I drinking last night? Such an experience may be vividly real to me, but if awake and sane I do not accredit it as an object of sense, as a *fact* of experience, unless I can correlate it with the body of fact already approved.

But scientific laws are merely "facts" of wider import, which rest on a foundation of broader experience such that, when objectified, they remain not as concrete elementary experiences but as general categories including many such elements. The scientific generalization or law must therefore be approved or evaluated in a way strictly analogous with that by which we test sense impressions; that is, to be acceptable it must fit in harmoniously with the whole content of experience—"it must explain all the facts."

In the solution of any scientific problem that method is most likely to lead directly to fruitful results, other things being equal, which favors the correlation of the data all along the line so that each correlation may become at once a datum for future research, instead of reserving the major correlations until near the end of the investigation. And in biological research, to return to our text, we must not forget for an instant that the organism is a *functioning* mechanism. We cannot hope to understand any animal or plant or organ until we have an exhaustive knowledge of how it works. The anatomical fact is dead and inert unless it is vivified not only by the "salt of morphological ideas" as it was so happily phrased years ago, but also by the fresh warm blood of functional explanations.

Anatomy has given place, within the memory of even the younger generation of biologists, to morphology, in which the explanation is indissolubly linked with the fact. Nor can we stop here. No anatomical fact is complete until its physiological significance is added thereto. Like the old-time descriptive anatomist, the "pure" morphologist (or shall we dubb him "poor morphologist?") has no longer any tenable standing ground. What I mean is that anatomical structure cannot be understood as the morphology of today demands that it must be understood without a full knowledge of the functions of the parts, and we must know evolution of function before we can have true knowledge of the evolution of structure. And as a matter of fact the biological public is just now coming into a practical realization of the truth that we must have a comparative physiology parallel with our comparative anatomy. It seems to us now very strange that we have had to wait a whole century after the birth of comparative anatomy for even the beginnings of a realization in practice of this elementary principle.

That researches in descriptive anatomy and in pure morphology are still necessary and will continue to be called for to the end of the age there can be no doubt; but it is important that we remember that no study of strucure is complete until the whole significance of that structure (including the evolutionary history of both its form and its function) is exposed and the whole complex of fact and meaning not only woven together into a single fabric, but fitted into the great pattern of reality as a whole in its proper place.

Now, no one of us can do this perfectly and, as time advances and the totality of the known becomes ever more vast and intricate, the difficulty grows apace. And yet this we must do in some measure in so far as we hope to rank as real builders in the permanent temple of truth. If we find ourselves unable to see the whole edifice in its proper perspective (as indeed who can?) we can at least build harmoniously with that nitch in which we find ourselves. Let no man delude himself with the idea that he is building for himself alone, that he builds on no other's foundation or that he can with safety ignore the labors of his coadjutors. Let no research worker hedge himself about and work in isolation; harmonious co-operation is the only possible way to get that breadth of view which all lack as individuals.

In our work on the nerve components we have endeavored to live up to these ideals. In so far only as we succeed in effecting wide and stable correlations from both the antomical and the physiological side can we hope to be able to build a structure which shall endure as a secure foundation for an ultimately complete functional subdivision of the nervous system.

PROCEEDINGS

of the

Ohio State Academy of Science

VOLUME IV, PART 5

Thirteenth Annual Report

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume IV, Part 5

Thirteenth Annual Report

OF THE

OHIO STATE ACADEMY OF SCIENCE

1904

ORGANIZED 1891 INCORPORATED 1892

PUBLICATION COMMITTEE

J. H. SCHAFFNER JAS. S. HINE E. L. RICE

DATE OF PUBLICATION, JUNE 15th, 1905

PUBLISHED BY THE ACADEMY
COLUMBUS, OHIO

Officers, 1905

PRESIDENT.

HERBERT OSBORN.

VICE-PRESIDENTS.

C. W. DABNEY, F. M. COMSTOCK.

SECRETARY.

L. B. WALTON.

TREASURER.

JAS. S. HINE.

LIBRARIAN.

W. C. MILLS.

EXECUTIVE COMMITTEE.

Ex-Officio.

HERBERT OSBORN, JAS. S. HINE, L. B. WALTON.

Elective.

F. C. WAITE, S. R. WILLIAMS.

BOARD OF TRUSTEES.

W. R. LAZENBY, Chairman, term expires........ 1906
J. H. SCHAFFNER, term expires............................. 1905
C. J. HERRICK, term expires............................... 1907

PUBLICATION COMMITTEE.

J. H. SCHAFFNER, Chairman, term expires.................... 1905
JAS. S. HINE, term expires................................ 1906
E. L. RICE, term expires.................................. 1907

Past Officers

PRESIDENTS.

1892. E. W. Claypole,
1893. Edward Orton,
1894. F. M. Webster,
1895. D. S. Kellicott,
1896. A. A. Wright,
1897. W. A. Kellerman,
1898. W. G. Tight,
1899. G. F. Wright,
1900. Josua Lindahl,
1901. A. D. Selby,
1902. W. R. Lazenby,
1903. C. J. Herrick.
1904. E. L. Moseley.

VICE-PRESIDENTS.

1892. A. A. Wright, Ellen E. Smith.
1893. D. S. Kellicott, D. L. James.
1894. G. H. Colton, Mrs. W. A. Kellerman.
1895. H. E. Chapin, Jane F. Winn.
1896. A. L. Treadwell, Chas. Dury.
1897. C. E. Slocum, J. B. Wright.
1898. Josua Lindahl, J. H. Todd.
1899. Chas. E. Albright, A. D. Selby.
1900. J. A. Bownocker, Lynds Jones.
1901. H. Herzer, Mrs. W. A. Kellerman.
1902. C. J. Herrick, C. S. Prosser.
1903. J. A. Bownocker, Miss L. C. Riddle.
1904. Lynds Jones, L. H. McFadden.

TREASURERS.

1892–95. A. D. Selby,
1896–98. D. S. Kellicott,
1899–04. Herbert Osborn.

SECRETARIES.

1892. W. R. Lazenby,
1893–94. W. G. Tight,
1895–03. E. L. Moseley.
1904. F. L. Landacre.

TRUSTEES.

1900–04. F. M. Webster,
1900–02. H. C. Beardslee,
1900–04. J. H. Schaffner,
1901–04. W. R. Lazenby.

PUBLICATION COMMITTEE.

1892–01. F. M. Webster,
1892–97. W. A. Kellerman,
1892–96. E. W. Claypole,
1897–99. E. L. Moseley,
1898–00. S. Belle Craver,
1900–04. J. H. Schaffner,
1901–03 L. H. McFadden,
1902–04. Gerard Fowke.
1904. J. S. Hine.

Membership

MAY 1, 1905

Life Member

McMillin, Emerson E. . . . . 40 Wall St., New York

Active Members

Aiken, Walter H., *Botany* . . . . Station K, Cincinnati
Albright, Charles E . . . . Columbus
Armstrong, C. A., *Geology* . . . . Canton
Ball, E. D., *Entomology* . . . . Logan, Utah
Baird, R. L., *Zoology, Geology* . . . . Oberlin
Barnard, B. C., ... Beaver Falls, Pa.
Benedict, H. M . . . . Univ. of Cincinnati, Cincinnati
Black, J. C . . . . Wooster
Bonser, T. A., *Botany, Geology* . . . . 02217 Monore St., Spokane, Wash.
Baur, Lizzie E., *Botany, Zoology, Physiology, Geology* . . . . Canton
Bownocker, John A., *Geology* . . . . O. S. U., Columbus
Britton, J. C., *Entomology* . . . Department Agriculture, Washington D. C.
Brockett, Ruth E., *Botany* . . . . Rio Grande
Brookover, Chas . . . . Buchtel College, Akron
Brugger, Harvey, *Botany* . . . . Fremont
Bubna, Matthias, *Entomology* . . . . 8 Heina St., Cleveland
Burgess, A. F., *Entomology*. . Dept, of Agriculture, State House, Columbus
Burr, Harriet G., *Botany* . . . . Worthington
Carter, Chas., *Entomology* . . . . Corydon, Iowa
Claasen, Edo, *Botany* . . . . 429 Woodland Ave., Cleveland
Clark, W. B., ... Granville
Coberly, Edward D., *Meteorology, Botany* . . Weather Bureau, Columbus
Collett, S. W., *Botany* . . . . Toledo, Iowa
Colton, George H . . . . Hiram
Comstock, Frank M., *Vert. Zoology* . . . . Case School, Cleveland
Copeland, W. F . . . . Athens
Dabney, Chas. W . . . . Univ. of Cincinnati, Cincinnati
Davis, V. H., *Horticulture* . . . . O. S. U., Columbus
Detmers, Freda, *Botany* . . . . 1315 Neil Ave., Columbus
Dunlap, Fred, *Forestry* . . . . Missouri Botanical Garden, St. Louis
Durrant, E. P . . . . Westerville
Dury, Chas . . . . 537 Ridgway Ave., Cincinnati
Dutton, C. F., Jr . . . . 64 W. Roy Ave., Cleveland
Edwards, E. H., *Zoology, Physiology* . . . . . 259 W. Clinton St., Cleveland
Feiel, Adolph . . . . 520 E. Main St., Columbus
Field, Irving A., *Biology* . . . . 61 Oxford St., Cambridge, Mass.
Fischer, Walter, *Botany* . . . . O .S. U., Columbus
Flynn, Maud, *Zoology* . . . . 338 W. 6th Ave., Columbus
Foulk, C. W., *Chemistry* . . . . O. S. U., Columbus
Fowke, Gerard, *Glacial Goelogy, Archaeology* . . . . Chillicothe
Frank, J. N., *Botany, Entomology* . . . . O. S. U., Columbus
Fullmer, E. L., *Botany* . . . . Berea
Gary, L. B., *Geology* . . . . Austinburg
Gibbs, David . . . . Norwalk
Gregory, W. M . . . . 116 Olive St., Cleveland
Grover, F. O., *Botany* . . . . Oberlin

GRIGGS, R. F., *Botany*..................1318 Forsythe Ave., Columbus
GUYER, M. F.,......................Univ. of Cincinnati, Cincinnati
HALSTED, G B., *Mathematics*..........................Gambier
HAMBLETON, J. C., *Botany, Zoology*.....212 E. Eleventh Ave., Columbus
HARRY, SCOTT G., *Ornithology*..............North Buckeye St., Wooster
HARTZELL, J. C..........University of the Pacific, San Jose, California
HARVEY, RUTH S., *Ornithology*.........................Bond Hill
HARVEY, GERTRUDE F., *Ornithology*.....................Bond Hill
HAYES, SETH .... Lancaster
HEILMAN, WM. T.................................. Canal Winchester
HERMS, W. B......................German Wallace College, Berea
HERRICK, C. JUDSON..................................Granville
HERZER, H., *Paleonology*............................ Marietta
HILLIG, FRED J.........................St. John's College, Toledo
HINE, J. S., *Entomology, Ornithology*...............O. S. U., Columbus
HOBBS, P. L., *Chemistry*.............................. Cleveland
HOCK, LULU.................................... Bowling Green
HOLT, W. P., *Botany*.................................. Toledo
HOUK, ELIZA P. T., *Chemistry*..........................Dayton
HUNT, THOMAS F., *Agriculture*.......................Ithaca, N. Y.
JAMES, C. B..........................Adeblert College, Cleveland
JAMES, DAVIS, L....................127 W. Seventh St., Cincinnati
JANNEY, JOHN J., *Horticulture*............93 Fifteenth Ave., Columbus
JENNINGS, O. E., *Botany*.........Carnegie Museum Annex, Pittsburg, Pa.
JONES, LYNDS, *Ornithology*..................College Museum, Oberlin
JUDSON, C. A., *Botany*.................235 Columbus Ave., Sandusky
KEELER, MISS H. L., *Botany*....................93 Olive St., Cleveland
KELLERMAN, WILLIAM A., *Botany*......175 W Eleventh Ave., Columbus
KELLERMAN, MRS. W. A., *Botany*.......175 W. Eleventh Ave., Columbus
KIEFER, R. J.. Attica
LANDACRE, F. L., *Zoology*........................O. S. U., Columbus
LAZENBY, WM. R., *Horticulture, Botany*............O. S. U., Columbus
LINDAHL, JOSUA, *Zoology*................ 312 Broadway, Cincinnati
LLOYD, JOHN URI...................Court and Plum Sts., Cincinnati
LOUTH, E. V., *Botany*................................Ashtabula
MALLY, C. W., *Entomology*...............Grahamstown, South Africa
MASTERMAN, E. E., *Zoology, Botany*.....................New London
MATEER, H. N., *Biology*............................. Wooster
MATHEWS, MARY E.....................................Painesville
McCOY, C. T., *Botany*.................317 E. Mulberry St., Lancaster
McELHINNEY, FRANK B., *Botany*.......................New London
McFADDEN, L. H., *Chemistry*....................... Westerville
MACKINNON, J. A., *Ornithology*..............................
....................care of Beecher, Peck & Lewis, Detroit, Mich.
MEAD, CHAS. S., *Zoology, Botany*............217 King Ave., Columbus
MERCER, W. F., *Biology*....................Ohio University, Athens
METCALF, ZENO P.....................................Plympton
MILLS, W. C., *Archaeology, Biology*................O. S. U., Columbus
MORSE, MAX W., *Zoology*..........600 W. 125th St., New York City
MOSELEY, E. L., *Zoology, Botany, Physiography* ....Sandusky
NELLES, GEO. T., ...U. S. Engraver's Office, Hickox Bldg., Cleveland
NEWELL, WILMON, *Entomology*..............Box 583, Shreveport, La.
OBERHOLSER, H. C......1454 Sheridan Ave., N. W., Washington D,. C.
ODENBACH, F. L., *Meteorology*............St. Ignatius College, Cleveland
OSBORN, HERBERT, *Entomology, Zoology*............O. S. U., Columbus
OSBURN, RAYMOND C., *Zoology, Ichthiology*..510 W. 124th St., New York
OUTHWAITE, JOSEPH H, *U. S. Ordnance*.................... Columbus

Oviatt, H. L., *General Science*............................ Norwalk
Pallister, H. D....................1128 Independence St., Cleveland
Parrott, P. J., *Entomology*..........................Geneva, N. Y.
Peppel, S. V., *Chemistry*............431 W. Main St., Louisville, Ky.
Pickel, Geo. J., *Chemistry*..............St. Ignatius College, Cleveland
Piwonka, Thomas......................243 Superior St., Cleveland
Prosser, C. S., *Geology*........................O. S. U., Columbus
Rhoades, W. R.,......................Gas Works, Springfield, Ill.
Rice, Edward L., *Zoology*................................ Delaware
Riddle, Lumina C., *Botany*......................O. S. U., Columbus
Roudebush, Lowell.................................. Owensville
Royer, John S., *Biology*.............247 N. Seventeenth St., Columbus
Sandres, J. G., *Entomology, Botany*..142 "A" St., N. E. Washington D.C.
Sanger, U. G., *Botany*...................................Newark
Schaffner, John H. *Botany*.....................O S. U., Columbus
Seaton, Miss F.,....................103 Glen Park Place, Cleveland
Selby, A. D., *Botany*....................Experminet Sta., Wooster
Simkins, J. D., *Glacial Geology*...............................Newark
Slocum, Mrs. Belle........................Wayne Bldg., Toledo
Slocum, C. E... Defiance
Smith, J. Warren, *Meteorology*............Weather Bureau, Columbus
Snyder, F. D., *Zoology, Ethnology*......................Ashtabula
Soule, William......................1804 S. Union Ave., Alliance
Stair, L. D..........................92 Wadena St., Cleveland
Sterki, Victor, *Conchology, Botany*................New Philadelphia
Stickney, M. E., *Botany*................................ Granville
Stockberger, W. W., *Botany*....Dept. Agricluture, Washington, D. C.
Stoner, Minnie A., *Domestic Science*..............O. S. U., Columbus
Surface, F. M., *Zoology, Botany*............................ Eaton
Sutton, J. G., *Physics, Geology*........................Rushsylvania
Sweezey, Otto H................1019 Olaho Lane, Honolulu, Hawaii
Taylor, Albert.. Bedford
Thompson, Mrs. King................167 W. Tenth Ave., Columbus
Tillman, Miss Opal I., *Botany*......................O. S. U., Columbus
Tight, W. G., *Geology*........................Albuquerque, N. M.
Todd, Joseph H., *Geology, Archaeology*.......Christmas Knoll, Wooster
True, H. L.......................................McConnelsville
Tyler, F. J., *Botany*.......Bureau of Plant Industry, Washington, D C.
Van Nostrand, Miss N. A..............Lake Erie College, Painesville
Waite, F. C..................Western Reserve University, Cleveland
Walton, L. B., *Biology*.................................. Gambier
Webb, R. J., *Botany*.................................Garrettsville
Webster, F. M., *Entomology*..U. S. Dept. Agriculture, Washington, D. C.
Wells, W. E., *Biology*................Antioch College, Yellow Spring
Werthner, William, *Botany*.............Steele High School, Dayton
Westgate, Lewis G., *Geology*.......................... Delaware
Wetzstein, A., *Botany*...................................St. Marys
Whetsel, J. A. G., *Botany, Zoology* ....Brooklyn, N. Y.
Whitney, W. C., *Biology, Geology*.......................Westerville
Williams, Stephen R., *Biology*...........Miami University, Oxford
Williamson, E. Bruce, *Ichthiology, Ornithology*.........Bluffton, Ind.
Wilkinson, E., *Botany*................................ Mansfield
Wolfe, E. E., *Botany*....................Marietta College, Marietta
Wright, G. Frederick, *Geology*............................Oberlin
York, Harlan H., *Botany*......................O. S. U., Columbus

Total Membership, 158.

Report of the Fourteenth Annual Meeting

OF THE

Ohio State Academy of Science

ANNUAL MEETING

The fourteenth annual meeting of the Academy was held at Cleveland, Ohio, November 25 and 26, 1904, in the Biology Building of Adelbert College.

The Academy was called to order at 1:30 on Friday, November 25, by President E. L. Moseley. The President appointed a membership committee consisting of Professors Comstock, Edwards, and Landacre, after which the reports of officers were heard.

The minutes of the previous meeting were read and accepted.

The secretary reported a proposition submitted to the newly formed Mathematical Society to affiliate with the Academy. Circular letters were mailed to all the Academy members and to all the Teachers of Mathematics, Chemistry and Physics in the State setting forth what seemed to be the obvious advantages of such an affiliation and while the members of the Mathematical Society seemed favorably inclined to the proposition it was not discussed before the society and was referred to a committee and nothing further came of it.

The secretary also reported the work done by the Allied Educational Association of Ohio and the appointment of the Secretary as a member of Executive Board of said Association until the Academy could act on the invitiaton of the A. E. A. to participate in its midwinter meeting. After a discussion of this invitation on motion of Professor A. A. Wright it was referred to the newly elected Executive Committee with power to act.

On the presentation of the reports of the treasurer and Board of Trustees, Professor Waite and Professor Walton were appointed an Auditing Committee to report at the next business meeting.

The report of the Treasurer showed the total receipts to be for the year, $182.01 and the expenditures to be $117.16, leaving $64.85.

The following is a brief summary of the report submitted by the Treasurer:

REPORT OF THE TREASURER FOR THE YEAR 1904.

To The Ohio Academy of Sciences.

For the year since our last annual meeting the receipts including balance from last year have amounted to $182.01 and the expenditures to $117.16 leaving a cash balance on hand of $64.85.

Summarized these receipts and expenditures are as follows:

RECEIPTS.

Balance from last year	$ 21.92
Membership dues	155.00
Publications sold and miscellaneous receipts	5.09
Total	$182.01

DISBURSEMENTS.

Ohio Naturalist, 127 subscriptions, 50 cts. each	$ 63.50
Printing of Annual Report	27.00
Miscellaneous expenses, postage, printing, etc.	26.66
Balance on hand Nov. 25th, 1904	64.85
Total	$182.01

Respectfully submitted,

Herbert Osborn.

The report of the Board of Trustees showed the total receipts of the year to be $308.89 and the disbursements to be $194.00 leaving a balance in the treasury of $114.89.

The Board of Trustees reported that the annual contribution of Mr. Emerson McMillin of $250.00 to the research fund had been received.

The matter of enlarging the size and scope of the Program Committee so as to include five members, one for Zoology, one for Botany, one for Geology and Physiography, one for Anthropology and Archeology and Ethnology, and one for Chemistry, Physics and Mathematics, was discussed and a motion to that effect was introduced by Professor Walton but was referred to the next business meeting by the President with the request that it be handed in in writing.

On motion of Professor Osborn the business meeting was adjourned and after a recess of ten minutes the reading of papers was begun.

At 3:30 P. M. the Academy assembled to hear the President's address on the Formation of Sandusky Bay and Cedar Point.

This was followed by the paper by Professor Halstead on Mathematics and Biology. The Academy here adjourned to the Physics Building to hear the illustrated lecture by Professor D. C. Miller on Radium.

At 7 P. M. the Academy met in the Biological Building for the business meeting.

The Academy elected Dr. Lindahl, Professor Osborn and Professor Wright a Committee on Nomination to report at the last business meeting.

On motion of Dr. Lindahl the Secretary was instructed to communicate to Mr. Emerson McMillin a vote of thanks from the Academy for his generous support of the research work of the Academy.

On motion by Professor Osborn a vote of thanks was extended to Professor Miller for his illustrated lecture on Radium.

At 7:30 P. M. the Academy adjourned to the Physics Building to hear an illustrated lecture by Professor Herrick on the Building Habits and Home Life of Birds.

The Academy reconvened at 8:30 on November 26 for a short business meeting. The Program Committee reported that all authors offering titles had complied with the provision passed at the preceding annual meeting, namely "that no titles should be read before the Academy unless an abstract was in the hands of the committee" except Mrs. Houk and Professors Kellerman and Schaffner. The committee recommended that the first paper by Mrs. Houk be admitted to the program and the second be deferred to a later time and made no recommendation in regard to the papers of Professors Kellerman and Schaffner as they were not present. The reading of papers was then taken up.

At 11 A. M. after the reading of papers was finished the final business meeting of the Academy occurred in which Professor Walton's motion that the Program Committee consist of five members was discussed and passed. This makes the committee consist of one member for Zoology, one for Botany, one for Chemistry, Physics and Mathematics, one for Geology and Physiography, and one for Anthropology, Archeology and Ethnology, in the order named.

The report of the Committee on Nominations was presented by Dr. Lindahl and is as follows:

For President..............PROF. HERBERT OSBORN
1st Vice President...........PRES. C. W. DABNEY
2nd Vice President........PROF. F. M. COMSTOCK

Secretary	Prof. L. B. Walton
Treasurer	Prof. J. S. Hine
Exec. Com. Elec.	Prof. F. C. Waite Prof. S. R. Williams
Mem. B. of Trustees	Prof. C. J. Herrick
Pub. Com.	Prof. E. L. Rice

A communication was read from Dr. Lindahl of the Cincinnati Society of Natural History and one from Pres. Dabney of the University of Cincinnati inviting the Academy to hold their next annual meeting at the University of Cincinnati.

On motion of Professor Osborn the Academy accepted these invitations and agreed to meet in Cincinnati for the next annual meeting.

The Committee on Membership reported the following named persons elected by the Executive Committee:

Chas. W. Dabney, Chemistry	Cincinnati, Ohio
Leslie H. Ingham, Chemistry	Gambier, Ohio
Albert Taylor, Entomology	Cleveland, Ohio
David Gibbs, Entomology	Norwalk, Ohio
F. C. Waite, Anat. and Hist.	Cleveland, Ohio
W. F. Heilman, Phys. and Biol.	Columbus, Ohio
E. P. Durrant, Zoo. and Geo.	Westerville, Ohio
G. B. Halsted, Mathematics	Gambier, Ohio

The following were elected by the Academy on motion of the Membership Committee:

E. L. Fullmer, Biology	Berea, Ohio
E. B. Eisenhard, Phys. and Zoo.	Cleveland, Ohio
C. B. James, Zoology	Cleveland, Ohio
Miss N. A. VanNostrand, Chemistry	Painesville, Ohio
G. J. Pickel, Chemistry	Cleveland, Ohio
W. M. Gregory, Phys. and Geo.	Cleveland, Ohio
Harlan E. Hall, Natural History	Mansfield, Ohio

The Academy adjourned at 11:30 a. m.

PAPERS READ.

President's Address—The Formation of Sandusky Bay and Cedar Point	E. L. Moseley
Mathematics and Biology	George B. Halsted
Radium—(Illustrated	D. C. Miller
The Building Habits and Home Life of Birds (Illustrated from original photographs	Professor Francis H. Herrick
Episodes in the Development of Rocky River	A. A. Wright
Some Ohio Mammals	James S. Hine
Our Smallest Carnivore (Putorius Allegheniensis) with Exhibition of Specimen	A. A. Wright

A meeting of the Academy was held at Columbus, Ohio, on Friday, December 30, at the Great Southern Hotel. At this meeting a paper was presented by Mr. J. C. Hambleton on "The Relative Value and Extent of Scientific and Literary Teaching in a High School Course." The discussion was opened by Mr. Boyd, and participated in by Messrs. Walton, Hall, Landacre, Misses Wilson, Riddle, Orton, and Dr. Dabney.

F. L. LANDACRE, *Secretary.*

PRESIDENT'S ADDRESS

Formation of Sandusky Bay and Cedar Point

E. L. MOSELEY

NORTHEAST GALES.

No wonder people talk about the weather! What else affects the fortunes of men so much? The night of June 28th, 1902, having decided to take an early train for Pittsburg and so not sleeping as well as usual, I listened to the rain beating against my east windows. Walking with rubber boots to the depot I found gutters overflowing, all the ditches between Sandusky and Cleveland carrying torrents of muddy water, and creeks swollen to the size of small rivers bearing on the load of sediment toward the bay and lake.

Others too had reason to remember that northeast storm. The water in the bay rose higher than for fifteen years before. Along the southwestern shore several acres of land were washed away. In Sandusky thousands of feet of lumber were washed off the docks. No boat ventured out of the bay.

In the lake the steamer Dunbar foundered southeast of Middle Island. Of the ten on board five took to the life raft and five to a yawl boat. The boat capsized and two of its occupants drowned. "The others, Captain Little, his wife, and daughter supported by life-preservers drifted about for several hours until they were borne to the vicinity of Kelley's Island," where they were rescued by the heroic efforts of Fred Dishinger, Sr., Fred Dishinger, Jr., and James Hamilton. The next morning a corpse was found on the beach less than two miles west of Huron and a little farther west on Cedar Point close to Rye Beach two more with a life raft bearing the word "Dunbar." On one was a watch still running and keeping nearly correct Eastern time!

On the east point of South Bass Island the waves piled up the gravel into a ridge which remains to this day. Along the east side of the Marblehead Sand Spit at the entrance to Sandusky Bay is a ridge supporting a growth of young willows and cottonwoods. It was probably formed at the same time.

"Not only is it true that the work accomplished in a few days during the height of the chief flood of the year is greater than all that is accomplished during the remainder of the year, but it may even be true that the effect of the maximum flood of the decade or generation or century surpasses the combined effect of all minor floods. In littoral transportation the great storm bears the same relation to the minor storm and to the fair weather breeze. The waves created by the great storm not only lift more detritus from each unit of the littoral zone, but they act upon a broader zone, and they are competent to move larger masses. The currents which accompany them are correspondingly rapid and carry forward the augmented shore drift at an accelerated rate."—Gilbert.

The greatest storms of the past century or those which were most effective because occurring at time of highest water were those of 1857–1862.

The water covered the land where the Sandusky Tool Factory stands and the street adjacent so that the workmen went to the building, then a saw mill, in row boats. It flooded the cellars on the south side of Railroad Street. The part of the city near the end of First Street and east of it was under water. These storms damaged the bridge across Sandusky Bay and the railroad near Port Clinton. Along miles and miles of shore and over hundreds of acres of lowland they killed trees that had stood for centuries. They cut away large slices of Eagle Island at the head of the bay and the last remnant of Spit Island at the mouth of the bay. They cut through the land west of Port Clinton giving an outlet for the Portage River about one-fourth mile farther west than before, but the breach was afterwards closed by the L. S. & M. S. R. R. Co. They built up on the northeast shore of Cedar Point long sand ridges twelve feet high on which hundreds of cottonwoods have since grown to a height of fifty or sixty feet.

The preceding statements may suffice to illustrate the sort of changes effected by northeast gales but those who have seen Lake Erie only when it is calm or stirred by winds of moderate force will be further impressed with its power by a brief notice of particular storms which are remembered by old residents or noted in the journal of the weather observer.

The northeast storms of 1857–1862 are said to have been more frequent and usually of longer duration than those of late years. Regarding this point a number of old residents agree and they are probably not mistaken, for the records of rainfall at the stations in this part of the country where records were kept so early show that the precipitation of 1857 and 1858 has not been equalled since.

Captain Freyensee and Mr. Haas, then in charge of the Swan, are sure that the water became exceedingly high in August, 1857, during a thunderstorm accompanied by a violent wind from the northeast. They think this was the highest water ever een at Sandusky. It was, however, of short duration, coming up early in the afternoon and falling during the night.

Captain Magle, then in command of the schooner H. C. Post, recalls a storm August 11, 1859, as occasioning the highest water he ever saw in Sandusky Bay.

Several persons have told me of a great storm in August, 1861. Northeast gales may have been more violent at other times, but this one coming when the water was already high and lasting several days was probably in its effect the greatest storm of the century. East of where the water works are now located it lifted the railroad track from its bed, and pushed it, in places, twenty feet away. At the foot of Columbus Avenue the dock was about a foot lower than now and did not extend so far north. A track then ran onto the dock from a turn-table south of it. In this storm water covered the dock and a great sea struck two empty cars that had been standing there with such force as to move them along the track and cause them to fall into the tu n-pit.

This storm washed away the steamer dock at Kelley's Island. The water went over the dock at Put-in-Bay, so that no landing could be made. The water has probably never reached so high a stage since.

Allan Winters recalls a northeaster in the spring of 1860, a greater one in the spring of 1861, but the greatest of all that of August, 1861.

Captain Haas remembers a great northeaster in 1862. There appear to have been none especially memorable in the spring of 1859 but the water was then so high that northeast gales not regarded at the time as extraordinary produced changes in the shores of considerable importance.

The Sandusky station of the U. S. Weather Bureau was established in 1877. In the next few years several northeast storms occurred more violent than any in recent years.

September 11, 1878, a gale began at five A. M. continuing until 5:45 P. M., Sept. 13, direction northeast and north backing to northwest in the afternoon of the 13th. Maximum velocity Sept. 11, thirty-four miles northeast; Sept. 12, forty-eight miles northeast; Sept. 13, fourty-four miles northeast. Total wind movement in twenty-four hours ending at noon Sept. 13, nine hundred and one miles. Unusually heavy rain on night of the 12th. Twenty-seven steamers, "Among them the largest propellers on the lake" and sailing vessels anchored behind Kelley's Island.

July 11, 1879, a gale began at 10:15 A. M. and ended at 3:10 P. M. both direction and velocity quite variable. A lull from

2:40 to 2:45 was followed by "a storm of wind and rain whose fury was almost indescribable, though fortunately of short duration, the wind reaching a velocity of sixty-nine miles from the north while the rain came down in such a deluge that one could not see two feet from the window, the thunder and lightning being appalling. The wind for ten minutes or from 2:45 P. M. to 2:55 P. M. reached and maintained a velocity of seventy-two miles per hour. At least 2.25 inches of rain fell during the fifteen minutes that the storm raged so violently. Heavy seas were dashed over railroad cars standing at least fifty feet from the water. At least one hundred chimneys were blown down."—From journal of Sandusky Weather Bureau Office. Some of these statements may be exaggerated as others in the journal, but not quoted, certainly are.

August 15, 1879, a severe northeast gale set in at 12:30 P. M., the velocity ranging from thirty to forty miles that day, but from midnight till six A. M., August 16, averaging forty-eight miles and attaining a maximum of fifty-nine miles at 3:30 A. M. In the afternoon of August 16, the direction was north and the gale ended with a velocity of twenty-five miles at 5:10 P. M. It caused very high seas and damaged several boats in the lake, no vessels of any kind entered or left the bay after the storm began. The total wind movement in twenty-four hours ending at noon August 16th, was nine hundred and fourteen miles. This and the average of forty-eight miles per hour for six hours are, I believe, unsurpassed in the records of the Sandusky office, while the maximum of fifty-nine miles has been surpassed but three times, viz., in the brief storm of July 11th, already mentioned; in a squall, August 9, 1885, sixty-three miles, northeast; and the following:

Jan. 31, 1881, a gale from the northeast began at 7:30 A. M., reaching its height, sixty-four miles northeast, at 9:35 A. M., Feb. 1st, and ending at 5:30 P. M. "The storm was one of the most severe known in these parts, the wind average forty-two miles per hour for eighteen hours; no extensive damage done." The water that winter was too low to be raised to an extraordinary height even by such a gale.

The highest water in Sandusky Bay since 1862 occurred April 23, 1882. The northeast gale began at 10:15 A. M. April 22, and continued till 4:30 P. M. April 23, the maximum, forty-four miles, occurring at 2:15 A. M. It averaged 32 5-12 miles per hour for twenty-four hours. The bay flooded everything on Railroad Street from one end to the other. At Marblehead a dock was washed away and three others damaged. The schooner Gallatin was wrecked about two miles from Pelee Island. Thirty vessels took shelter behind Kelley's Island.

The effect of some of these same storms in producing lasting changes on Cedar Point and elsewhere about the bay will be mentioned in subsequent chapters. Storms of much less violence than these seem awful to those who are on the lake at the time. On May 31st, 1903, the water striking the Ohlemacher dock on Marblehead was dashed so high that people at a distance could see it over the tops of the limekilns and on another occasion Alex R. Clemons estimates that the spray went more than fifty feet above the top of this high dock. In front of the large stone house which stands near the lake in Marblehead village a piece of limestone estimated to weigh two and one-half tons was broken loose from the bed rock and moved along shore twenty-seven feet by a single storm. Looking from this place Mr. Clemons has counted as many as seven wrecks, all in sight at one time.

EFFECT OF TILTING OF THE LAND.

Lake Beaches.

When the glacier had retreated beyond the northern boundary of Ohio a lake extended along the southern border of the ice. The south shore of this lake was at first about twenty miles south of where Sandusky now is. Its western extremity was at Fort Wayne, Indiana, whence the water flowed to Huntington and via the Wabash and Mississippi to the gulf. As the ice melted from the southern part of Michigan, outlets were formed into the Grand River valley through which the water flowed to another glacial lake occupying the southern part of the basin of Lake Michigan and thence toward the Mississippi through the depression now utilized for the Chicago drainage canal. The later outlets were lower than the earlier ones and consequently the lake level fell and each time it fell its southern shore came nearer Sandusky. Each position of the shore is marked by a beach. The highest beach extends from Fort Wayne through Van Wert, Tiffin, Pontiac, the southern part of Norwalk and Berlin Heights, from there on east continuing only a few miles from Lake Erie. The middle beach extends through Bellevue, Monroeville, the main street of Norwalk, Berlin Heights and Elyria. The lowest beach passes through Clyde, south of Milan through Berlin Heights and along Euclid Avenue, Cleveland, through northwestern Pennsylvania and western New York.

Each beach, when formed, must have been approximately level as it followed the shore of a lake. But they are no longer level. Leverett has found that the lowest one is 168 feet higher at Crittenden, N. Y., than at Cleveland, showing that the land between these places has been tilted to that extent. Old beaches near the other Great Lakes indicate that the whole region has undergone tilting.

GILBERT'S RESEARCHES.

Whether this tilting is still going on or ceased long ago does not appear from an examination of these old beaches. In 1895 Mr. G. K. Gilbert found evidence that it was still continuing. By comparing the heights above the normal lake level of a bench-mark in Cleveland and one at the head of the Welland Canal with the heights of the same as carefully determined in 1858, it appeared that the land near the northeast end of the lake had risen as compared with Cleveland. In like manner he found that tilting was still going on in the region of Lake Ontario and Lake Huron and Michigan.

DEEPENING OF THE WATER.

Inasmuch as the tilting produces a rise of the land toward the northeast as compared with that toward the southwest it is elevating the point of outlet of Lake Erie as compared with the rest of the lake. As the lake is continually receiving water through the Detroit River and other sources the elevation of the point of outflow raises the level of the water throughout the entire basin.

In 1860, H. A. Winters now living in Sandusky, had occasion to visit Eagle Island many times. In a pond too deep for hip boots, but which he crossed with his boat, was a walnut stump whose sapwood had rotted away. The heartwood about four feet in diameter was still well preserved and showed that it had been neatly chopped off. Alvin Fox told him that he had helped to chop the tree in 1828, when the land about it was all dry. Through the summer of 1860 the stump stood in about two feet of water.

According to J. W. Lockwood, who lives on the north side of Sandusky Bay near the Plaster Beds, a man named Craighill cut an oak supposed to be two hundred or three hundred years old about 1823 or 1824 on what was then a dry prairie but where there has been a marsh ever since. This marsh borders what is known as West Harbor in the peninsula north of Sandusky Bay.

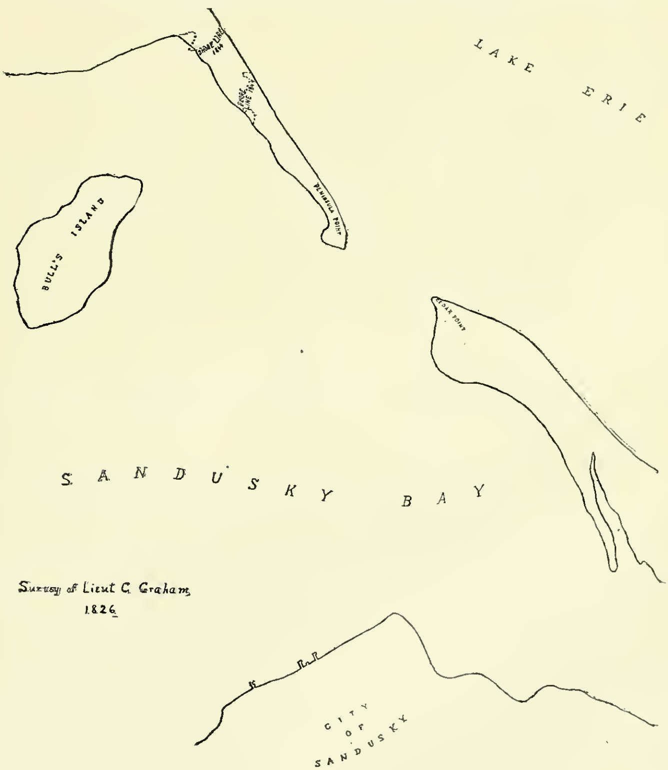
These observations and many others made it clear that the water had deepened but in view of the fluctuations produced by rainfall and the lack of early records of rainfall they did not afford a means of calculating with any degree of accuracy how fast the deepening would progress if the rainfall remained uniform. Not until the fall of 1904 was any means discovered of making such a calculation. It came from studying the parallel ridges which traverse the terminal portion of the Cedar Point peninsula. These have been built up by great northeast storms and the approximate age of each of the principal ones has been determined from the vegetation upon it. The older ones are lower than those formed in the past century. By dividing the difference in height between the highest aqueous deposits in two ridges by the number of centuries intervening between their formation I have obtained the average number of feet the water has risen each century. It is about 2.14. A detailed description of these ridges is given in the part of the paper dealing with Cedar Point.

EFFECT OF VARIATION IN THE RAINFALL.

The deepening of the water produced by tilting of the lake basin has not been noticeable within the past half century because of greater fluctuations produced by variations in the rainfall. Those who recall the high water of 1858 to 1862 know that it has not been so high since. Moreover in 1894 and 1895 it was lower than they had ever seen it before, unless their observations began before the middle of the century. These facts seemed to disprove the theory that the water is gradually getting deeper. In an article in the National Geographic Magazine for August, 1903, I showed that, since 1870, when the Weather Bureau established stations about the Great Lakes, there has been a very close correspondence between rainfall and lake level. When the rainfall is above normal the lake rises, and when below normal it falls; whether we consider particular years, parts of years or periods of years. More recently I have learned that at the places in this part of the country where a record of rainfall was kept as early as 1857 the rain that year or the next was very heavy. Bulletin C., U. S. Weather Bureau, gives the rainfall of the United States from the earliest records to the end of 1891. In it are twenty-two places within one hundred miles of the Great Lakes that have a record for the year 1858. From data in this bulletin I have made the table, which includes besides these, St. Louis, Peoria and Marietta, although they are somewhat farther away. In fourteen of the twenty-five places the maximum rainfall for the whole period of record—in one instance seventy-one years—was in 1857 or 1858. In most of the other places the rainfall of 1857 or 1858 has been exceeded not more than three times. No wonder there was high water in 1858 with such precipitation as that. If the table were brought down to 1901, the years given above would still stand pre-eminent, for the rainfall from 1891 to 1901 was generally light—lighter in 1895 when the lake was also lowest than in any other year since the Weather Bureau was established.

Town	State	Years in record	No. of yrs. surpassing 1857 & '58	Maximum Rainfall	Year
St. Louis........	Mo.	55	0	68.8	1858
Aurora..........	Ill...	16	0	47.4	1858
Ottawa.........	"	18	0	47.2	1858
Peoria..........	"	36	0	53.4	1858
Winnebago......	"	14	0	45.2	1858
Marengo........	"	39	1	56.9	1851
Janesville.......	Wis.	5	0	42.6	1858
Milwaukee.......	"	48	2	50.4	1876
Marquette.......	Mich.	29	5	42.9	1881
Grand Rapids....	"	11	2	51.9	1855
Bellefontaine....	Ohio	13	0	54.1	1858
Cleveland.......	"	36	4	53.6	1878
Marietta........	"	71	0	61.9	1858
New Lisbon.....	"	10	1	47.1	1866
Steubenville.....	"	19	0	55.1	1857
Buffalo.........	N. Y.	34	9	60.3	1878
Cooperstown.....	"	38	1	58.1	1890
Geneva.........	"	25	0	42.6	1857
Hamilton.......	"	20	0	61.9	1857
Lowville........	"	24	0	47.3	1857
Mexico..........	"	21	0	57.3	1857
Palermo.........	"	38	8	51.3	1859
Penn Yan.......	"	52	0	44.4	1857
Pierrepont Manor	"	21	3	50.7	1866
Rochester.......	"	57	3	48.7	1878

December 28, 1904, the wind having blown from the southwest all night with velocity between twenty and twenty-five miles an hour, the water in the bay was 4.1 feet below the zero of the gauge, which represents approximately the mean lake level from 1861-1895. Continuous gauge readings have not been kept at Sandusky except for short periods, but men whose business has been on the docks for more than twenty years said this was the lowest water they could remember. The high water in the northeaster of June 29, 1902, which was the highest for fifteen and perhaps for twenty years, is said to have reached nearly to the top of H. C. Post and Company's dock. December 28, 1904, I found the water seven feet, eight inches below the top of this dock, so that the difference was not far from seven



MAP I.

and a half feet. Only about half a foot of this was due to difference in the stage of water preceding the storms, about three feet to the southwest wind and the remainder to the northeast wind. The maximum wind velocity in the northeaster of June 29, 1902, was only thirty miles. In 1888 the anemometer of the U. S. Weather Bureau office at Sandusky was removed from the West House to the government building which is lower and not so near the bay, causing considerable decrease in the total wind movement registered, so a satisfactory comparison of wind velocity in the later and earlier storms cannot be made. In the great storm of April 23, 1882, the water was probably more than a foot and a half higher than on June 29, 1902. This I infer from information furnished by men at the docks. The record of gage readings at Cleveland shows the stage of water to have been about a foot and a half higher at the time of the earlier storm so that the wind effect may have been nearly as great in the later one.

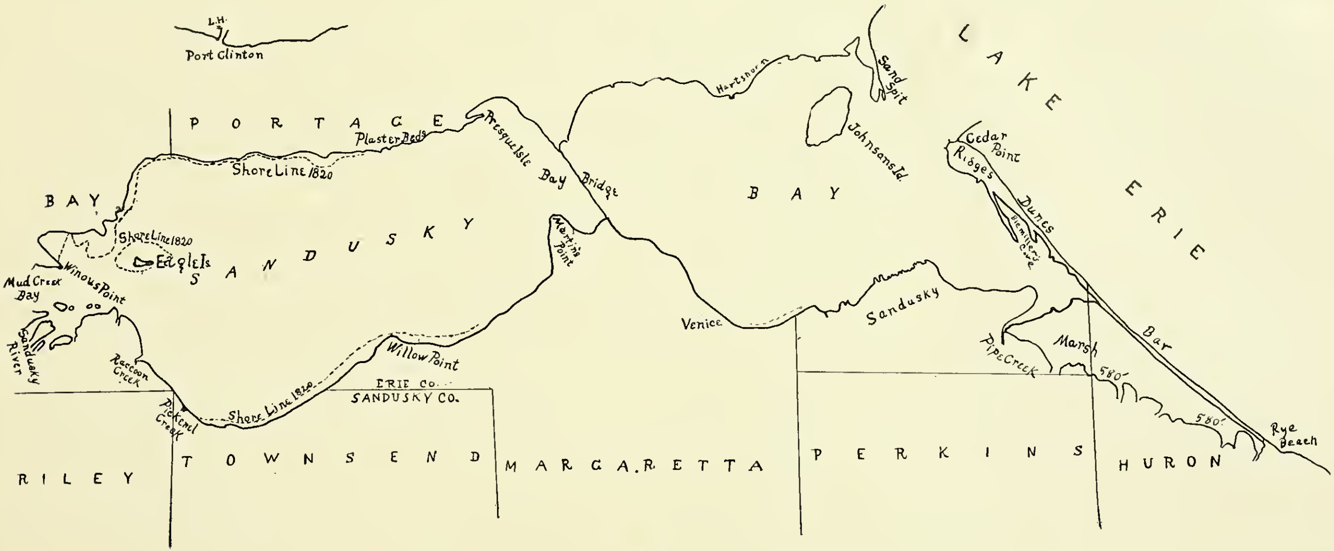
Only once in several years is the water at Sandusky raised or lowered from its normal level so much as three feet by the wind, while a change of four feet must be very rare. At Cleveland the change of level due to the wind is generally less than a foot, while at each end of the lake in extreme cases it is six or seven feet.

The fluctuations in level of Lake Erie due to changes in the amount of water received and lost in a single year are never much more than two feet, and in some decades do not exceed two and a half feet.

LAND LOST IN A SINGLE CENTURY.

PENINSULA POINT.

Map I, taken from a U. S. Government Chart shows Peninsula Point as it was in 1826. The distance between it and Cedar Point was about 3,000 feet but the water off the end of Peninsula Point was so shallow that when lowered by drouth and wind the distance from point to point was much less. H. A. Lyman, the old lighthouse keeper, told me he had seen the water so low that he thought the distance across was only about 300 feet. The Indians used to swim their ponies across and B. F. Dwelle, who lived until 1902, and many others of the early settlers on the Marblehead peninsula crossed in the same way. Cattle raised on the peninsula were driven to market this way, but not after 1830.



L.H.
Port Clinton
PORTAGE
Plaster Beds
Shore Line 1820
BAY
Shore Line 1820
Eagle Is
SANDUSKY
Mud Creek Bay
Winous Point
Sandusky River
Raccoon Creek
Pickerel Creek
Shore Line 1820
Willow Point
ERIE CO.
SANDUSKY CO.
Presque Isle Bay
Bridge
Martins Point
Hartshorn
Sand Spit
Johnsons Id.
BAY
LAKE ERIE
Cedar Point
Ridges
Dunes
Venice
Sandusky
Pipe Creek
Marsh
580'
580'
Bar
Rye Beach
RILEY
TOWNSEND
MARGARETTA
PERKINS
HURON

Map II.

Some of the sand dunes near the south end of Peninsula Point were nearly as high, Mr. Lyman said, as the highest on Cedar Point. Three other persons recall their height as twenty feet or considerably more. Along the west side was clay covered with black soil several inches deep. The trees were not willows and cottonwoods alone, as on Marblehead bar which has since formed farther west, but white oak 2½ feet in diameter, red oak, shell bark hickory, ash, elm, buttonwood, basswood and red cedar. Mr. Lyman wrote me: "quite as large timber on it as there is on Cedar Point, viz., sycamore and oak." At one time there was an orchard.

Before 1834 the lake had made an opening through the northern end, after which it was known as Spit Island. The government spent "$40,000" in trying to save it. A large boarding house was erected for the workmen who built a crib along the whole length of the lake side. But in spite of efforts to protect it from the waves, it was worn away at both ends and the last remnant disappeared in the high water of about 1860.

EAGLE ISLAND AND SQUAW ISLAND.

In 1820, when the first survey was made Eagle Island in the western part of the bay (see Map II) contained 134.42 acres.

There are now, 1904, two remnants which together contain less than two acres. The western one of these as seen from the Steamer Hayes Aug. 30, 1904, appeared to be entirely marsh. The island being located where the waves of the bay attain considerable force has suffered from every northeast storm, those of 1858–'62 dealing it some severe blows.

Miles Pearson told me that his mother, who was born in 1809, when a girl used to walk to the island from the south, crossing a channel on a plank, or in dry times stepping across. At that time the cattle used to go there to graze. Porter Wright told me that he walked to the Island and could have ridden a horse all the way; there was no danger of miring. He remembers when it had more than a hundred eagles' nests and it was unsafe, after the eaglets were out of the nests and on the ground, for a man to cross the island without carrying a club. Eagles' nests were also numerous on the neighboring mainland.

Squaw Island at the mouth of the Sandusky River, throughout the early part of the century was connected with the peninsula to the west, which was much wider than now. As late as 1855 it was separated merely by a channel for small boats. In 1873 the channel had widened to 230 feet, and in 1904 it was about 600 feet. It is said that the Indians used to swim their ponies from Peach Island to Squaw Island and then ride along the north bank of the river to Fremont.

RECESSION OF THE BAY SHORE.

Map II shows the present shore line taken from the topographic sheets of the U. S. Geological Survey except the northeast portion, the sheet for which has not yet been issued. The broken line shows a portion of the shore as it was at the time of the first surveys 1809–1820. In quite a number of places lines running from section lines to the bay shore whose length is recorded in the original surveys have been remeasured in recent years by local surveyors or by myself and these data, as well as a comparison of the old plats with the recent maps published by the U. S. Geological Survey, have enabled me to estimate the amount of land lost. The greatest change has been along the south shore from Martin's Point west. Here the bay is wider than farther east and as erosion is accomplished mostly by the northeast storms, which raise the level of the water, the waves beat upon this shore with greater force than on the shore opposite. The west line of section 34 Portage Annexation, northwest extremity of Erie county I found in 1904 had shortened about 66 rods since the first survey. The middle line of the west half of section 35 Charles Judson found in 1895 had shortened 62 rods. At other places the change shown by surveys is not so great. However, the survey by Sylvanus Bourne, 1820, of Township VI North, Range XVI East 1st Meridian, at the west end of the bay, gives no measurements for the portion lying south of Mud Creek Bay and the shore line in this part of the township is not correctly drawn on his plat. Porter Wright who has owned much of the land in this region told me in 1904 that the whole west shore of the bay south from Eagle Island had washed away as much as eighty rods within his remembrance. He is seventy years old. At Dudrow's in Townsend Township he knows the recession of the shore is more than that. Miles Pearson thinks 100 rods of land north of the mouth of Raccoon Creek has washed away in the last fifty years and 60 rods between Raccoon Creek and Pickerel Creek in the same time. These estimates H. A. Winters who also has long been familiar with the region considers not too high.

At five places on the south shore of the western half of the bay, according to estimates of the several land owners, encroachment of the water has been from three to six rods in as many years, most of it in the last three years, because the water has been high. For seven or eight years preceding the last three there was hardly any encroachment in some of the places. In the western extremity of Erie county, where the road turns south, I found the bay eating it away, Sept. 2, 1904. The old plat shows the nearest part of the shore 49 rods away. Charles W. White estimates that the shore was 15 or 20 rods farther north about twenty-five years ago. Just west of this the northwest quarter of section four, Townsend, contained:

1820		122.21	Acres.
1886	about	80	"
1890	"	70	"
1904	"	65	"

About an acre of this farm, i. e., a strip a rod wide, disappeared in the storm of June 29, 1902, already referred to and another acre in a northeaster the latter part of March, 1903.

The whole north shore of the bay from the mouth of the river nearly or quite to the bay bridge has receded since 1820, but less than twenty rods in most places. The west line of Section 4 Danbury township is given in the original survey, Wright and Mulhall's, as fifty-seven chains. In 1904 I found it to be but 47.11 chains, showing a loss of nearly forty rods. The shore line in their time was probably near where Presque Isle is now. South of section 9, Portage Township, were 21.42 acres of school land according to the survey of P. F. Kellogg, 1820. Only three acres of this now remain, but some forty rods south of the present shore may still be seen at time of low water the remains of a chimney marking the site of a house. J. W. Lockwood remembers being there about 1835 when there was quite a yard between the house and bay.

Between Venice and the western part of Sandusky the shore has receded about twenty rods.

The amount of land replaced by open water since 1820 may be roughly estimated as 2⅔ square miles, without counting any west of Eagle Island. The amount converted into marsh, including the marshes west of Eagle Island, is probably eight or ten square miles so that the total loss of land about Sandusky Bay may be as much as twelve square miles.

MARSHES.

The recession of the shore line has been due both to erosion and higher water, the formation of marshes to the latter cause alone. The greatest change has occurred at the head of the bay. Seen from the deck of the Steamer Hayes, August 30, 1904, when about half a mile west of Winous Point, the marsh and open water appeared to extend three miles or more from north to south. A great part of this was dry land during the early part of the 19th century, but how large a part it seems impossible to ascertain. A plat of the region giving the results of a survey completed in 1893 by Edgar Brennan, C. E., distinguishes tillable land, including woods, from marsh. By inspecting this map and making a rough estimate of the percentage of tillable land in each section, I conclude that in the sections, Nos. 21, 22, 23, 26, 27, 28, 34 and 35, the total amount is not more than half a section. From the plat of Bourne's survey of 1820 it would appear that these eight sections then contained about 5½ sections of land. Part of this is now open water, part of it marsh. In several other sections of Bay township a good deal of marsh has formed within the past century. Porter Wright who went there in 1836 remembers that section 35, now nearly all marsh, used to be dry land. In section 2 of Riley township he owns 200 acres of marsh which formerly was dry land. Mulberry stumps are still standing there where now the water stands half the time. He estimates that more than a thousand acres of marsh south of Graveyard Island used to be dry land except after heavy rain. "Honey locust, elm and poplar used to grow over a good deal of the land where the water now (1904) is 2½ feet deep. All the way from the bay to Peach Island was good dry land, mostly prairie; there was a streak of timber half or three quarters of a mile south of the river, some of it still standing on the highest ground. All the marsh from Raccoon Creek to South Creek was prairie land covered with blue joint and hoop pole grass (Spartina cynosuroides), a grass seven or eight feet tall which does not grow where it is wet. The region between South Creek and Green Creek is now marsh, but when I came here it was mostly dry land."

The total amount of land west of Eagle Island converted into marsh or open water since 1820 is probably six or eight square miles. In Margaretta Township, Erie County, the recent topographic map shows about 1⅔ square miles of marsh. Most of this was probably above lake level until after 1820. On the north side of the bay the marshes are less extensive.

At the east end of the bay the marsh that extends from the mouth of Pipe Creek to Rye Beach has spread over considerable of the low land along its inner margin within the past century. Two miles east of Perkins Township the late Albert Judson, county surveyor, found the line originally run by Almon Ruggles and supposed to mark the border of the land at the time of the early survey, to cross the marsh about half a mile out from the present margin of the land, the water and mud over the intervening region being a foot to 18 inches deep. This was in 1887. A lot, half a mile square, had been converted into marsh. Between this and the Perkins Township line the recession of the shore line he found to be very much less. Walter Devlin says, cattle used to go out half a mile toward Cedar Point farther than now and find pasture and places to lie down, though they had to wade through perhaps a foot of water near the hard ground from which they started, where the water was deeper than farther out.

WHAT THE WATER HAS COVERED.

SUBMERGED HUMAN REMAINS.

Squaw Island at the present mouth of Sandusky River rises two feet or a little more above mean lake level. The soil is sandy and probably alluvial. Graves have been found in all parts of the island including parts washed away in recent years. In some of these the bones were below the present water level. On August 27, 1904, I visited this island with John Fitzgerald, keeper of the Winous Point Club House, who had often found bones there. A cottonwood fifteen inches in diameter whose roots had been loosened by the high water had fallen on the land the year before, and had earth still clinging to its upturned roots. Imbedded in this earth I found a molar, a rib and two cervical vertebræ, all human, also fragments of Indian pottery. All of these must have been beneath the water, probably a foot or more below the level of August, 1904. A few yards from this cottonwood another had fallen from the same cause and lay parallel to the first, its diameter about thirty inches. In the earth brought up by its roots Mr. Fitzgerald had seen human leg bones, which before the tree was uprooted must have been below the water a foot or so. That these graves on Squaw Island are not very ancient may be inferred from the fact that in one of them was found a silver gorget on which is engraved the lily of France. This is now owned by Charles Sadler of Sandusky.

The early French settlers about the head of the bay used to bury their dead on Eagle Island, which at the time was probably part of the mainland. Some thirty years ago the graves had been washed out and skulls still sound and other bones in great numbers lay on the beach.

Graveyard Island where the "French" or "British in 1812" buried their dead has been almost if not completely submerged at times of very high water.

On the north shore of the bay east of Hartshorn's dock, on land owned by Mary Cook, a grave was found in 1903 close to shore. There was a tradition among the old residents of the peninsula that at this point an Indian burying ground had once extended out where the bay is now.

At the northeast corner of the city of Sandusky, near the ship yard, copper kettles and Indian trinkets were washed out by the high water of 1858.

Graves of some of the early white residents of Sandusky just west of Ilg's brewery were opened by the waves so that coffins stuck out of the bank and bones fell out 1850-'52.

Submerged Forests.

Persons who came to Erie county in the forties remember seeing about the marshes connected with the bay many dead trees which they believed had been killed by high water, as the trees were standing where it was too wet for such trees to grow. Allen Remington, who came in 1839, saw great numbers of dead trees that had been recently killed by high water standing where there is now marsh in the eastern part of Sandusky Bay. Lake Erie in 1838 reached a higher level than ever before. Many trees were killed also by the high water of 1858–62. George Hinde, who owned a large tract of land in the northeast corner of Perkins Township, Erie County, had hickory trees two feet in diameter killed at that time. In the northwest corner of Huron Township eighty acres or more from a tract of 213 owned by Walter Devlin had become marsh by 1904. On a good deal of this were walnut trees.

J. W. McGookey, who lives in Margaretta Township, Portage Annexation, says: "About 1858–'62 large trees of oak, elm, and many other kinds were killed by water standing over their roots, along all the farms near his place and on the school lands in the northwestern part of the township. Many other forest trees were washed into the bay, as was also an orchard north of the land now owned by Lewis Neill."

Jonas Pearson of Vickery, informs me that in or near the northeast corner of Riley Township, Sandusky County, sixty acres of timber, hickory, oak and ash, were killed a number of years ago when the water came up and stayed up several years. Porter Wright told me that in section 36, Riley Township, on land he formerly owned, oak, hickory and large elms were killed by high water at about the time of the Civil War. Also on land he still owns in sections 35 and 36, well back from the bay shore, all the biggest and best ash, oak, elm, and hickory, many of them he thinks two hundred years old, were killed at the same time. He never saw elsewhere such a heavy growth of timber as on Graveyard Island and Eagle Island. It was principally honey locust. In 1860 Allan Winters rowed his boat among the standing trees at the head of the bay. He says a hundred acres or more of them were killed by high water at that time. His observations were chiefly north of the river and so refer to different sections from those mentioned by Wright or Pearson.

In the part of the bay north of Townsend Township abundant remains of a prostrate forest extend out half a mile from the present shore, according to J. W. Lockwood, who found them so close together as to make it difficult to steer a scow among them. Later J. G. Yeckley, who lives near, confirmed the statement that trunks with roots attached extend out half a mile from the present shore. He took from the water some five hundred trees still quite sound, using them for posts. They were mostly oak and hickory, though others got out a few of walnut. The main object in removing the timber was to clear the bottom so as to permit the hauling of seines. He spent parts of three years in this work.

In the marshes east of Sandusky I found in March, 1898, a number of prostrate trunks with roots extending down some distance so that I thought they must have grown there before the land had been converted into a marsh. A number of these were sixty rods or more from the present shore of the marsh. From the shallower part of the marsh nearer shore I was informed that in a dry season hundreds of walnut trunks had been removed for timber, and that a number of walnut stumps were still standing where the ground was too wet for trees of that kind.

"In tracing the west line of Huron Township across the marsh in 1885 it was found that the original survey made about 1810, referred to trees standing at different places where for many years past has been only marsh."—Ed. Hinde.

Hunters in pushing their skiffs through the marsh often strike submerged timber with their setting poles. Besides walnut I found basswood, cedar, pine, beech, and sassafras, but it is not certain that all of these grew near where they now lie. Planks have been found two or three feet below the surface of the marsh. The floods of 1858–'61 carried not only these but many trees that had been uprooted. All that had been growing on Cedar Point between the Carrying Ground and the vicintiy of Rye Beach were swept off into the marsh. These have perhaps all rotted since, but others of kinds more enduring that grew along the Huron River or other streams may have been carried into the lake by the freshets of that time and washed over the Cedar Point bar by the northeast storms.

Cedar stumps still standing where the trees grew have been found in several places about the bay, their roots and in some instances their tops below the water level. Sept. 11, 1904, the high water of the summer having washed away a portion of Rosebush Point (near the end of Cedar Point) I noticed a number of stumps, cedars and others, with roots at or below water level. A root of one of the cedars was fourteen feet long. Nov. 19 when I was on another part of Cedar Point the dredge at work near the south end of the lagoon between ridges No. 2 and 3 brought up a cedar stump whose roots the men said must have been two or three feet below water level. The water at the gage at the time was about .6° below 0. They had previously found in the work on the lagoon three or four cedar stumps below water level, the roots two or three feet below.

In 1894 or 1895, Chas. Dildyne saw several cedar stumps in a group west of the Black Channel and not far from its mouth. They had been cut with an axe but their tops are below water except in very dry times. Three other persons have told me of seeing these same stumps or some in the same vicinity.

In 1894 and 1895 William Hertlein worked a piece of land between Venice and Bay Bridge, which other years has been covered with water. He found many cedar stumps still in place. The muck was three or four feet deep but the cedar roots were, partly at least, in the clay underlying it. The water in May, 1904, he said was as much as three feet above the uppermost roots.

SUBMERGED MARL BEDS.

The marl used by the Sandusky Portland Cement Works at Bay Bridge was formed from calcareous springwater probably above lake level. The greater part of the two hundred thousand tons used for cement has been taken from below mean lake level, the bottom of the deposit being about five feet below.

At Willow Point a gravel beach half a mile long several rods wide and rising two or three feet above mean lake level has been formed of pebbles most of which are calcareous tufa. The marsh back of the beach rests upon clay and contains no tufa. The pebbles must have been derived from tufa beds that formerly existed where the bay now is, but at what level cannot be told.

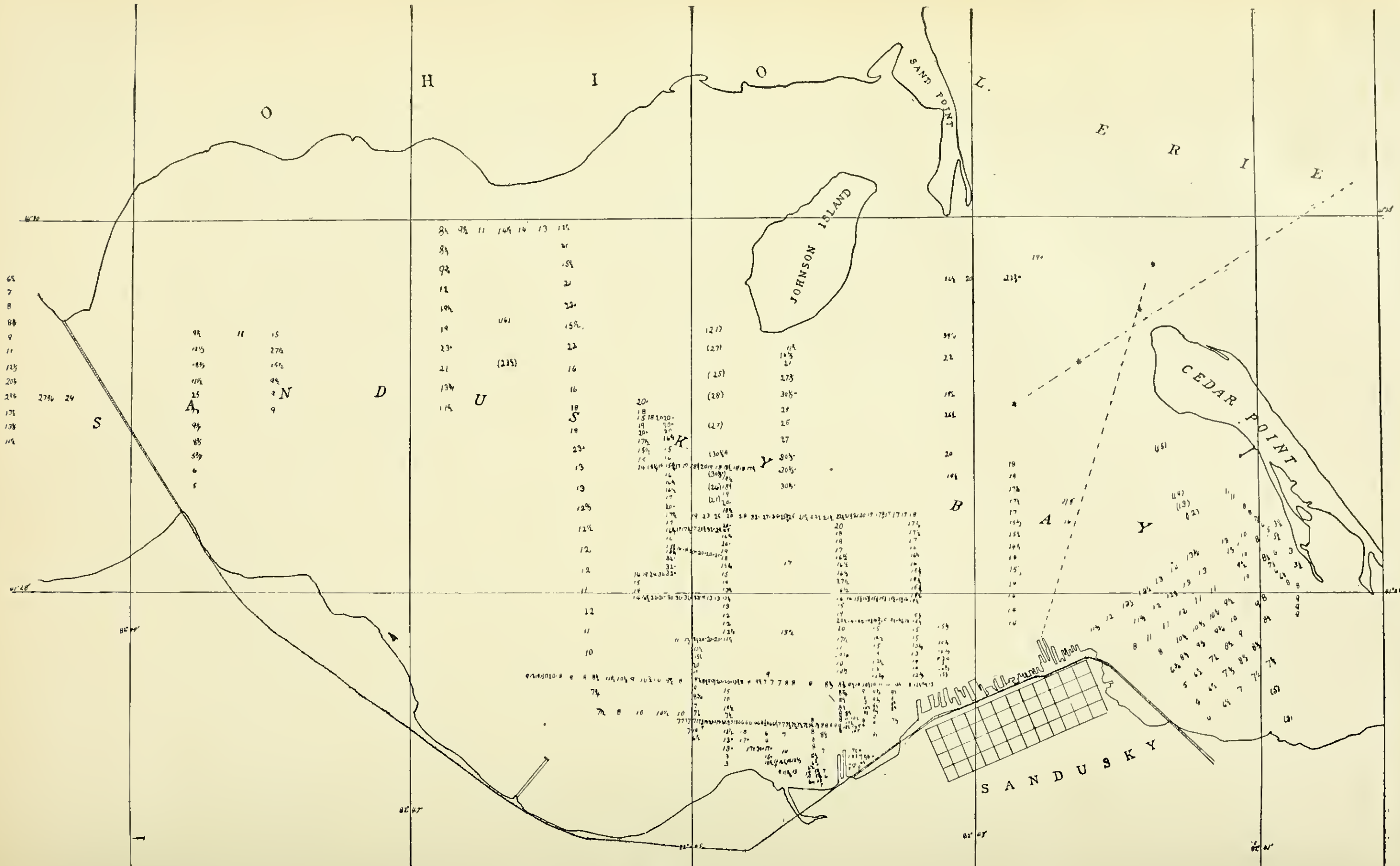
SUBMERGED VALLEYS AND THE BOTTOM OF THE BAY.

The possibility of tracing the valleys of streams through the bay occurred to me in 1898 while gathering data in regard to submerged timber in the marsh east of Sandusky. A hunter who had often pushed a boat through the marsh told me that along a line extending out from the mouth of Plum Brook a setting-pole would go down through the mud about 12 feet whereas on either side it struck hard bottom at two or three feet. A fisherman of whom I enquired regarding the character of the bottom of the bay told me that in setting stakes for his nets west of Johnson's Island he had found that the soft mud was very deep along a line from the bay-bridge toward the range-lights south of the island.

In January, 1901, I began making holes through the ice and testing the bottom by means of an auger welded to an iron rod along which would slide an arm provided with a set-screw, making it convenient to push, turn or lift the auger at any depth the rod would reach. The water of the bay is mostly less than 12 feet deep. The rod used the first winter was 18 feet long. Where the mud was very deep extensions were put on. The original rod was lost with the point about 30 feet in the mud and 39¼ feet below the surface of the ice near the old range lights south of Johnson's Island. Later I used a rod 20 feet long with an extension piece 12 feet long.

The bottom of the bay is nearly level so that soundings giving the depth of the water do not disclose any valleys (Map IX). By testing the bottom at numerous points along lines transverse to the general course of the stream it was found that off the mouth of each stream was soft mud containing organic matter and readily distinguished from the glacial drift on either side. It had been thought the glacial clay might be softened by being covered by water so long, but experience showed that as a rule the weight of two men would push the auger but a few inches or a foot or two into this clay, whereas it might be pushed twenty feet or more into the deposits made since the glacier. The agitation of the water by waves has caused the loose mud to fill the original valleys, making the bottom of the bay approximately level. These valleys made by the streams, when they flowed miles farther than now to reach lake level are thus traceable by the lines of soft mud.

On the maps showing the location of borings it is not a fault of the draftsman that the lines are not parallel and do not intersect others exactly at right angles. On these maps I have attempted to give the location of the borings as actually made, though it may have been the intention to make them along north and south or east and west lines. The difficulties in always carrying out such intentions were several; unreliability of a compass in determining the directions accurately; mist obscuring landmarks I had intended to use; errors in maps and charts. In some of the earlier work the drawbridge across the bay in the L. S. & M. S. bridge was used as a landmark. After a time it was discovered that more than ten years before the drawbridge had been changed to a position nearly 1000 feet farther southeast but that the charts of Sandusky Bay with corrections to date still represented it in the old position. The platting of work done east of the mouth of Pipe Creek and in the marshes beyond was especially difficult because the border of the marsh is so indefinite and there was nothing in the vicinity



MAP III.

Figures show distance in feet from upper surface of the ice to upper surface of glacial clay; ( ) location or depth a little indefinite.

from which measurements could be made, and scarcely anything visible within two miles whose location is given on any chart or map. The plat in the auditor's office was found to be in error to the extent of forty-five rods. No detailed and accurate map of the region exists to this day. In the work done the first winter the importance of careful location of the holes with reference to points on shore was not realized, their location with reference to other holes sufficing to show—what was not previously known—that it was possible to trace these submerged valleys. Sometimes in tracing a valley it became desirable to test the bottom a short distance to one side of the line we had been following. Accordingly we measured off 16 rods or some other distance at what seemed to be a right angle to the main line and on making a hole there decided to go farther in the same direction. The deviation from the direction intended was usually discovered in some way either before or at the time of platting the work on the charts, even though it required a journey of several miles the next day to reach the spot again and trace the angles on paper. The location of borings shown on Map III, with the exception of those enclosed in parenthesis, are believed to be correct within ten rods or a little more, most of them much nearer than this. With reference to other borings in the vicinity the error in the location is very small, if made the same winter.

Nearly a hundred boys have assisted in this work and in determining the age and height of the aqueous deposits in the ridges on Cedar Point, some of them many times. Altho serving without pay, often in bad weather and enduring fatigue they have made no complaint. I wish there were space to mention their names. On one occasion a boat was taken along on the ice, at another time a life preserver. Both proved useful. Twice at least the shore has not been reached until after dark and on one of these occasions there were some anxious parents. Many mittens have been lost or discarded and many tools, large or small, gone to the bottom of the bay or farther, but no lives have been lost or limbs broken. Feet have been wet and sometimes more, but few colds have been taken and many probably avoided or cured by the vigorous outdoor exercise.

I am indebted to Mr. August Klotz who has generously put at my disposal without charge the resources of his machine shop, and to Charles Judson, C. E., who has often loaned me his instruments and assisted in other ways.

Sandusky River.

I have not tested the bottom of the bay farther west than Danbury, 82 degrees, 50 minutes west longitude, but Adam Hayder in driving stakes for fish-nets has noticed a zone of deep mud extending from Eagle Island to the Bay Bridge. Into this he drives the stakes six feet and then does not know that they touch clay. This belt of deep mud is as wide as the length of eight leaders, 35 rods each, and the northern margin of it is about this distance, seven-eighths of a mile, from the shore at the Plaster Beds and as much as a mile at the Port Clinton road. From the south side of this belt of mud on the meridian of Port Clinton hardpan extends toward Willow Point. Off Willow Point for the length of six leaders, stakes will hold, but the next six lengths stakes do not hold, the blue clay or hardpan being too hard.

I found no place near the bay bridge where the hard bottom was quite thirty feet below the ice. It is not likely that anywhere farther west the river ever cut much deeper than this, for in the portions of the bay bridge where piles were driven the rock is nowhere much more than thirty feet below mean lake level. Nor does the valley deepen appreciably for about three miles east of the drawbridge. South and southwest of Johnson's Island a depth exceeding thirty feet was found in quite a number of places. Here the river received several tributaries and its valley is probably considerably deeper than farther west. The borings do not show any tributaries farther west and it is not likely that any important ones existed between the bay bridge and the vicinity of Johnson's Island. Among the old dismantled range lights southeast of Johnson's Island the hard bottom is at least forty feet below mean lake level and may be considerably more than this. The greater part of a day was spent in attempting to trace the valley farther east but deep sand prevented reaching the clay except in a few places. The deep water off the end of Cedar Paint and in 1842 a deep depression between the end of Cedar Point and the dismantled range lights, with glacial clay only 20 feet below lake level a short distance to the south and to the north, show that the Sandusky River once flowed where steamers now pass in and out of the bay.

Tributaries to the Sandusky River.

Lines of borings across the bay indicate the course, though they do not show in detail, the submerged valley of Meadow Brook which now enters the bay west of Hartshorn's dock on the Peninsula, and a stream now entering the bay east of Bay

MAP IV.
Buried Valleys under Sandusky Bay. Compare with Map III.

Bridge station giving outlet to the water from the Rockwell springs and formerly the other bold springs at Castalia. By means of a canal the water of these other springs has been diverted to the stream that discharges at Venice. This stream five hundred years ago extended nearly two miles farther northeast than now, joining Mill Creek about 82 degrees, 45 minutes W. longitude, 41 degrees, 28 minutes N. latitude. The former course of Mill Creek has been worked out in detail but near its confluence with Sandusky River south of Johnson's Island its location is not entirely certain. Here the river valley was probably so deep below the surrounding country that even short tributaries cut deep ravines on approaching it and the multiplicity of these makes it difficult to work out the ancient topography in detail.

Between Mill Creek and Pipe Creek no important streams enter the bay nor do the numerous borings indicate that they were ever here. North of Sandusky the surface of the clay slopes gradually toward the former course of the river.

East of the Pennsylvania Railroad dock a little creek formerly entered the bay. Its water is now carried by Whiskey Run sewer. The valley was easily traced as far as the dock but, owing to its small size and the fact that its banks were cut down by the waves of the bay, I was long puzzled to know what became of it beyond the dock or dredged channel. Certain spots farther north where the mud is deep, found when making lines of borings not designed to show the valley of this stream, were supposed to be due to it, but the connection was not found until a number of trials were made. From the Pennsylvania dock the valley extends nearly north.

Pipe Creek.

The tracing of the former course of Pipe Creek was not satisfactorily completed until parts of four winters were devoted to it. The first attempt, March 16, 1901, served to show that it was traceable, but the work could not be carried far because of the weakening of the ice which in the warm sun thawed rapidly that day—more rapidly than in the open bay where the water under it is deeper and consequently not warmed so fast. In the following winter many borings were made between Pipe Creek and Cedar Point and the valley appeared to reach the Point near the west line of Huron township. When, however, the borings were platted as well as the poor maps would permit it seemed probable that the deep muck near the west line of Huron Township was due to the former confluence there of two small streams not shown on the maps, though they may be seen by one walking along the L. S. & M. S. R. R. east of Pipe Creek. They must have broadened and deepened as they went on through what is now marsh. Deep muck found near the Carrying Ground was assumed to be in the submerged valley of Pipe Creek. The next winter we were disappointed in finding the ice unsafe east of Pipe Creek, but in December, 1903, we traced the valley without any difficulty from the present mouth of the creek to the Carrying Ground and later in the winter under the Carrying Ground and out into the lake.

Valleys Under the Marsh.

Some long lines of borings in the marsh east of Pipe Creek together with some shorter ones near the mouths of the streams served to show quite well the buried valley of Guston Inlet and less fully that of Plum Brook and a small stream entering the marsh beyond the West Huron Club House. All these valleys are filled with muck that is easily penetrated by the auger. Mingled with the organic matter is alluvium brought by the streams in time of flood and in the vicinity of Cedar Point a small amount of sand, some of it no doubt having been blown over the ice in winter.

Map V.

Buried valley of Pipe Cre:k and of streams entering the marsh farther east. Figures show depth in feet of clay below upper surface of ice.

The Black Channel.

This does not properly belong under the head of submerged valleys but as it is popularly believed to be a remnant of some former stream, it seems best to mention it here. As the entrance to Sandusky Bay was much narrower in the early part of the 19th century than now, it has been supposed that at an earlier date no opening existed there but the course of the Sandusky River was continued by the Black Channel and the outlet was at the farther end. This is disproved by the fact that glacial clay and even rock make a continuous barrier between Sandusky and Cedar Point.

The Black Channel and the smaller channels running through the marsh do not follow the buried valleys. The latter pass under them and have no connection with them. These modern channels give outlet to the bay for the streams which a few centuries ago had separate outlets into the lake. They also serve to distribute the water over the marsh or carry it from the marsh when the wind raises or lowers the level of the bay. At such times the currents may be quite strong and this serves to keep them open and deep as they are. They may be compared to the tidal inlets in the salt water marshes.

The Black Channel has had its present position for at least sixty years. It is not, however, very old because three centuries ago Pipe Creek and the streams farther east had no connection with Sandusky Bay. Then there was not a continuous marsh extending from Pipe Creek to Rye Beach but each creek was bordered by marsh separated from those on each side by dry land.

Character of the Post-Glacial Deposits at the Bottom of the Bay.

These have not been studied carefully, the aim having been to find the depth of the glacial deposits below the surface. In the West Huron marsh the material overlying the glacial clay is composed largely of the remains of marsh vegetation, black or dark brown, extending in places to a depth of twenty feet. In the submerged valley of Mill Creek muck was found at a depth of 32 feet of such purity as to show that a marsh once existed there. Sometimes on withdrawing the auger marsh gas bubbled up through the hole in the ice; on one occasion it issued in considerable volume so that when lighted it produced quite a blaze. In this and other valleys in the bay muck has been found at various depths, but it does not constitute a large percentage of the material filling the valley. This must have been transported and in most instances probably consists of a mixture of materials from many places, some of it washed into the bay by streams, some derived from action of the waves on the shore. Materials from the same sources are found over much of the bottom of the bay but I do not recall finding muck or other remains of old marshes far from the present shores except in the submerged valleys.

The thickness of the post-glacial deposits in any part of the bay can be determined approximately by subtracting the depth of the water given on the government chart of Sandusky Bay from the depth of the clay shown on Map III, allowing one or two feet for difference in water level at the times depths were determined. The water in winter is lower than in summer and so I have generally found its depth less than that shown on the government chart.

In some places scarcely any mud covers the clay. In many places the uppermost part of the clay is so soft that the precise level at which it is struck cannot be told from its resistance to the auger pushed into it, but when pulled out it clings to the auger and an inspection of it as it is being removed with a stick rarely leaves any doubt as to whether it is clay or mud. The latter not only looks different, but has much less tenacity. In a great majority of cases the clay is blue, but in some places both near the south shore and the north shore it is red, not having been long enough in contact with organic matter to reduce the ferric to ferrous compounds.

In some places, e. g., along the line extending north from the foot of Wayne Street to the Outer Range Rear Light, the transition from mud to clay is abrupt. Here the mud is so soft that it is difficult to tell when the auger first touches it and the weight of one man is sufficient to push the auger nearly or quite to the clay. The hard and nearly level surface of the latter probably indicates that it was planed off by the waves a few centuries ago when the lake and bay had reached a high enough level. Shore currents probably carried the products of erosion away, leaving the bottom free from sediment. When the water had become so deep that the lower layers were no longer subject to agitation by the waves, light particles easily held in suspension and so carried far from their source were deposited here, gradually forming a bed of soft mud resting upon the firm glacial clay.

In going north along this same line, which is on the meridian of the court house, no sand was noticed until we were a mile from shore, where it was barely perceptible, gradually increasing toward the north. At a mile and a quarter it was necessary to turn the auger through six or eight inches of sand. From here on the sand increases rapidly. A quarter of a mile south of the Rear Range Light we bored through six feet of it without reaching the bottom. The layer of sand found between a mile and a mile and a quarter north of the city is not at the surface of the mud but a few inches below it, while several feet of mud intervene between the sand and the clay. As long as the entrance to the bay remained narrow it is probable that great waves traversing the lake were checked enough there to prevent sand being carried so far toward Sandusky, but when the washing away of Spit Island widened the opening much of the obstruction was removed and the great storms of about 1860 distributed sand (some of it, no doubt, derived from Spit Island) farther in the bay than it had come before. In later years the narrowing of the entrance by the construction of a submerged jetty extending northwest from the Outer Range Front Light as well as the scarcity of great northeasters may have prevented further accessions of sand and given time for mud to be deposited on top of that which was left here in former years.

We have never found thick deposits of sand except where it had apparently come in from the lake. The bar west of Biemiller's cove has much sand and gravel which has been moved along shore from the north, but a short distance west of the bar the sand forms only a thin surface layer.

WORK OF THE GLACIER AND PREGLACIAL CHANGES.

The glacier rested heavily on the region about Sandusky and left its impress on the rock in many places, the grooves of Kelley's Island and Marblehead being larger than are known elsewhere. Near the north shore of the bay large grooves have been noticed north-east of Hartshorn's dock and at the Ohlemacher quarries. Along the south-east shore of Johnson's Island are numerous distinct grooves extending beneath the water. On the higher ground back from shore they are continually being uncovered in stripping the rock as the quarry is extended and a number of fine ones have been quarried away in the last three years. In the city of Sandusky wherever the overlying clay is sufficiently deep to protect the rock from weathering, its removal discloses glacial marks. Near the bay we have noticed them at the Ship Yard and in the basement of Emerich's drug store. In the summer of 1904 when the foundation was being prepared for the concrete work at the foot of Columbus Avenue, a piece of limestone showing plain glacial marks was broken off twelve feet below the surface of the water.

Besides the valley now partly filled by Sandusky Bay several other rock valleys in the vicinity lie sensibly parallel to the main axis of Lake Erie.

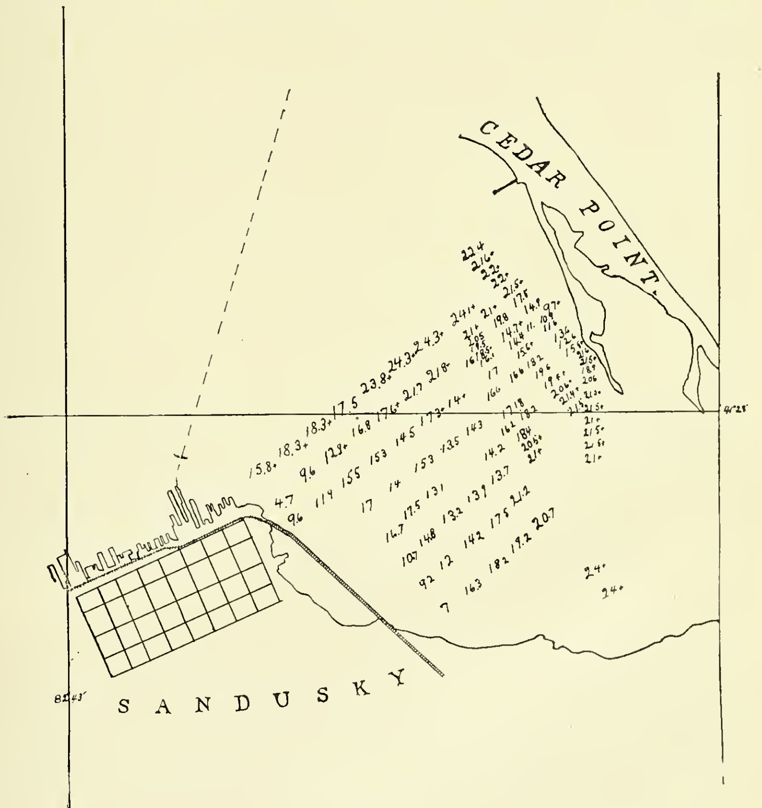
The parallelism of these valleys to each other and to the grooves makes it probable that all of them were made by the glacier. Although the general movement of the glacier over Ohio was more nearly southward the motion of the lower portion of the ice in this vicinity during the time that most of the erosion was done was about seventy-five degrees west of south, the direction being determined by the valley now filled by Lake Erie.

Under the bay the glacial deposits are of the same character as on the land. Overlying the rock is hardpan from a few inches to two feet or more in depth, containing pebbles and boulders in abundance, the greater part of them of limestone which the glacier transported but a short distance. The matrix in which the stones are imbedded contains a large percentage of calcium carbonate which probably accounts for its toughness compared with the clay above it, which the auger penetrates with much less difficulty. In the lower part of the clay are boulders but not so many as in the hardpan. Pebbles are very numerous within a foot or so of the rock. Limestone boulders appear to predominate near the rock to a greater extent than at a higher level—judging from some exposures on the land. Except within four feet of the rock the clay seems to be almost free from stones of any size. It must have been held in suspension by the water of the glacial lake and gradually settled to the bottom at a distance from the foot of the glacier.

PREGLACIAL CHANGES.

No deep preglacial valley runs through Sandusky Bay. At the power house on Cedar Point the rock is 46 feet below water level. Off the end of Cedar Point the water is 40 feet deep. West of the entrance to the bay in 1842 was a circular depression in which the water was 42 feet deep. In the vicinity of the old range lights south of Johnson's Island soft mud extends to a depth of forty feet or more below mean lake level. I know of no attempts to find the rock at greater depths at the entrance to the bay or west of it. In the bay bridge of the L. S. & M. S. Ry. the piles are driven to rock which is in most places less than 30 feet below the surface of the water. The longest space without piles is 1700 feet but the rock does not slope toward it in such a way as to indicate a rock valley there. How much of the broad but shallow valley occupied by Sandusky Bay resulted from preglacial erosion I have no means of judging.

Gypsum has been quarried near the north shore of the bay, 3 miles west of the Bay Bridge, for about three quarters of a century. At first it was ground by a windmill, but about 1835 by a steam mill. Thirty-ton schooners anchored a mile out in the bay and loaded for Detroit, Erie and other ports. This is said to have been the only locality on the Lakes where plaster was obtained at that time. The gypsum beds lie mostly below lake level. Long ago about four acres of the bay at Plaster Beds were diked off, the water pumped out and gypsum quarried. A few years ago one of the plaster companies operating at Fletcherville several miles west of Plaster Beds mined gypsum



MAP VI.

Rock between Sandusky and Cedar Point. Figures give depth in feet and tenths below 0 of water gage. + indicates rock was not reached, but, if following a number less than 21, was probably within one foot.

under the bay until the water broke through the roof of the mine. Gypsum has also been found near shore between Fletcherville and Plaster Beds, and in 1902 a good bed was found 1½ miles south of the bay on Mr. Meggit's farm in Margaretta Township. In view of its occurrence both north and south of the bay and near the bay near the north shore it seems probable that it once extended over considerable of the region now occupied by the portion of the bay west of the bay bridge. The relatively rapid solution and erosion of the gypsum compared with the more resisting limestone may have produced this broad valley. Much of the earlier plaster was derived from boulders, so it is likely that the glacier assisted in enlarging this valley. East of Sandusky the depth of limestone below the surface is shown on Map VI. An inspection of this chart will show that over most of the region the rock is not far from level. It rises near the Sandusky shore and near Biemiller's cove. It drops off rapidly to the north just as it does along the city front, also to the east of a line extending from the Jarecki Chemical Works to the Lake Laboratory.

In other parts of the bay I have never struck rock except in a few places near shore, e. g., near the mouth of Mill Creek and near the south end of Johnson's Island.

CEDAR POINT.

Cedar Point is the peninsula, 7¾ miles long, forming part of the eastern boundary of Sandusky Bay. It is not, as has been supposed, a mere sand spit, but has a foundation of clay resting upon the rock and extending, in the middle section, nearly up to low water level. It may be divided into three portions which we will call the bar, the middle or dune section, and the terminal or ridge section.

THE BAR.

This is a low narrow strip of sand extending from Rye Beach, 2¼ miles west of the Huron River, to the Carrying Ground, a distance of about 4¾ miles. The height of the crest above mean lake level averages about 6½ feet, in the highest places barely exceeding ten and in the lowest descending to a little less than five. From the crest toward the lake a bare beach slopes steeply for a foot or two then gradually to the water whose height of course determines its breadth. At low stages of the water, such as prevail in fall and winter, the breadth is about four rods, continuing for miles with little variation. It does not at any place extend out into wide reaches of sand flats for the water off shore deepens more rapidly than that adjacent to the terminal portion of Cedar Point. Away from the lake the slope is quite gradual and the distance from crest to marsh is between eleven and sixteen rods throughout a great part of the length. In the vicinity of the west line of Huron Township and the mouth of the Black Channel the breadth is twenty-four rods or more. Quite near Rye Beach the breadth in the fall of 1904 was only 2–4 rods and most of the way for the first mile between three and six rods. In a number of places the lake has washed the sand over onto the marsh making little projections two or three rods long, so that the shore of the marsh has not an even outline like that of the lake. Some of these were made in 1904 and others apparently within a year or two before.

Composition of the Bar.

The visible material of the bar like that of the remainder of Cedar Point is largely sand, consisting of quartz, magnetite and garnet, but unlike the remainder it has throughout its whole length gravel at the surface. On the bare beach the gravel is abundant and many of the pebbles are as large as hens' eggs, the quantity and to some extent the size increasing as one goes toward Huron, the direction from which they have come. They consist largely of quartzite and other metamorphic rocks derived presumably from boulders in the clay between Rye Beach and Huron. Limestone is scarce and not from any beds in the vicinity. Shale fragments flat, angular and dark are scattered over the beach or strewn thickly upon the sand more or less apart from the hard pebbles. They too increase in abundance as one approaches Dr. Esch's place where a bed of Ohio shale outcrops, showing many spherical calcareous concretions three feet in diameter, some of them with tops cut off by the glacier and still bearing the scratches.

Near Rye Beach fragments of brick of various sizes, rounded like the other pebbles, attract attention by their red color. These are probably from a brick house belonging to Jabez Wright, grandfather of Mrs. Esch, and a well known surveyor three quarters of a century ago. The house stood north of the present shore and south of a road, on the north side of which was an orchard. The lake took the orchard, the road, the house, and finally the man, who after a dark night was found dead at the base of a high bank where the lake had encroached upon the new road.

A list of the things washed ashore or drifted along the Cedar Point beach would fill pages. Among the more common are fragments of wrecks, and other driftwood, articles of various sorts thrown or lost from boats, coal, cinders, nuts, fish, bones of various vertebrates and shells of molluscs. We once found on a lonely part of the beach the skeleton of a swan which probably after being wounded perished on the lake and was entombed in the sand near the crest of the beach by the same storm that brought it ashore. Even the cartilages of the trachea with its curious convolution inside the sternum were still preserved. Various things through long attrition by sand and pebbles have come to resemble the latter so closely that their nature is a puzzle to the novice—wood, coal, peat, brick, drainage tile, pottery and glass made opaque and quite free from sharp points or edges. The source of the last when its nature is comprehended may not be so puzzling to account for as that of the peat which occurs at various places along the lake shore to the very end of Cedar Point. This is derived from the remains of marsh vegetation which once flourished where the lake is now. The bar is not so far out as formerly and part of the marsh that was originally behind it is now in front of it. These fragments are perhaps broken loose in winter, when the water is low and the ice that has been resting upon the exposed marsh, sometimes in winrows ten or fifteen feet high, is drifted ashore by the wind. At least I found many large and angular ones nearly free from sand after the ice had broken up Jan. 1, 1905. Some of them were fifteen inches thick and more than four feet in length. A long line of these extended northwest from a point about 2½ miles from Rye Beach. Toward Rye Beach for quite a distance none were noticed though within a mile or so of it there were a dozen or more, increasing in size toward the beach, the largest eighteen inches long. There are never large ones on this part of the beach. The small ones are derived from the marsh at the outlet of Sawmill Creek close to Rye Beach. The portion of this marsh now covered by the lake bristles with the roots of button-bush so close together that no large masses of muck are loosened from among them. A third locality from which the muck is derived is probably along the shore of the Carrying Ground.

Between the buried valleys of Plum Brook and Sawmill Creek the clay is probably so near the surface that soon after the marsh muck was uncovered by the lake moving the bar over onto the marsh, it was torn loose and perhaps ground to pieces by the waves but I cannot say but what some still remains where it was formed and now covered by the sand and water of the lake.

Allen Remington and Jacob Lay have seen large quantities of peat cast ashore by storms occurring when there was no ice. The former says the storms accompanying the high water of

1859 uncovered the bog and threw large masses of peat on the shore in such numbers that one could follow the shore for miles jumping from one to another. In 1904 we found peat in the sand between two ridges near the lighthouse which were formed about 1860. It had been moved along the shore and cast up by the waves. Years later Mr. Lay saw peat strewn along the beach almost as thickly as described by Mr. Remington.

VEGETATION OF THE BAR.

The vegetation of the bar is scanty and limited with rare exceptions to such species as grow on poor soil. Andropogon scoparius, Panicum virgatum, Populus monilifera and Salix of several species—amygdaloides, wheeleri, cordata, lucida, alba vitellina—constitute probably nine-tenths of it all. On October 8th I walked the whole length but with that exception have not traversed the greater portion of it, save in winter. Besides the species mentioned above, the following are all that I have noticed, those among the first being more common than those toward end of the list.

Solidago canadensis
Teucrium canadense
Ascelpias syriaca
Verbascum thapsus
Oenothera biennis
Euphorbia polygonifolia
Ptelea trifoliata
Cornus
Vitis riparia
Celastrus scandens
Rhus typhina
Nepeta cataria
Erigeron canadense
Andropogon furcatus
Sporobolus cryptandrus
Muhlenbergia mexicana
Cenchrus tribuloides
Lycopus sinuatus
Gentiana andrewsii
Pastinaca sativa
Equisetum robustum
Equisetum pratense
Prunus virginiana
Platanus occidentalis, 8,
Ulmus americana, 4,
Quercus velutina, 5, all small,
Quercus imbricaria, 1,
Fraxinus pubescens, 2,
The last three species near Rye Beach only.
Rosa carolina
Achillea millefolium
Xanthium canadense
Gnaphaluim polycephalum
Eupatorium perfoliatum
Strophostyles angulosa?
Lathyrus maritimus, about a mile and a quarter from Rye Beach, the only place I have found it in Ohio.
Liriodendron tulipifera, one,
Neillia opulifolia, one.

Doubtless a dozen more could be found by searching in summer for a single day, perhaps a score by trespassing on the marsh a yard or two, but compared with the 395 species, or thereabouts, which I have found on the older portion of Cedar Point, this list is small indeed. In all this barren waste of nearly five miles there is not a cedar nor pine and I believe no maple, black cherry, hackberry, mulberry, basswood, locust or any nut bearing tree, except a few oaks within three quarters of a mile of Rye Beach and too young to bear. Aside from cottonwoods, willows and one of the buttonwoods I noticed but a single tree more than about twenty-five feet tall. Of plants as common in the dune section of Cedar Point as the cactus, bearberry and sea sand-reed I saw not one on the bar.

Between the crest and the vicinity of the marsh only a few of the plants in the preceding list are met except at rare intervals, a waste of beard-grass and panic-grass with here and there a cottonwood or willow being all that meets the eye. Throughout the entire length of the bar and also in much of the dune section the vegetation is scanty except in a narrow belt along the bay shore. Here the wind that blows across the sand transporting the finer grains has its velocity checked by the marsh vegetation and so drops its load. Moreover the bar slopes so gradually from the crest that a strip several yards wide near the bay is but a few inches above water level.

As water may be found anywhere by digging down to lake level, the sand near this level is kept continually moist by capillary action, but several feet above it the sand at the surface often becomes quite dry. Even at the same height above the water the fine sand contains much more water than the coarse and so is better suited to meet the needs of plants. To test the two sorts, sand was taken from among the bushes near the bay and from a point a few rods nearer the lake where the vegetation was scanty. The former was much the finer. The following experiments were tried with them. Hollow cylinders of glass and iron with cloth tied over the bottom were filled with sand and made to stand upright in shallow water so that the water was drawn up through the sand by capillary action. The fine sand contained a small amount of organic matter and when thoroughly dry was not readily wet even by water poured upon it but once wet it drew up much more moisture than the coarse sand and retained it longer as shown by the tables.

Centigrams of Moisture Found in Ten Grams of Sand Taken From Top of Sand Filling Pipes Standing In Shallow Water.

Date	Conditions	Height above bottom. cm.	Coarse sand	Fine sand	Difference
Nov. 9	Water in jar barely exhausted	14	45	115	70
" 10	Water supply exhausted more than 24 hours.............	14			40
Dec. 14	Water supply exhausted about five days...........	14	3	41	38
" 19	Water 3 cm. deep in jar......	14	40	110	70
" 19	Water 1 cm. deep in jar......	23	3	5	2
" 21	Taken from about 2 cm. below surface.............	20		38	
" 21	Taken from about 4 cm. below surface.............	17	33		
Jan. 16	Taken from middle of cylinder which had contained 14 cm. of sand. Water exhausted several weeks......	7	4	56	52

RESULTS FROM PLANTING OATS IN COARSE SAND AND FINE SAND.

Date of planting	Number		Height above water cm.		Date Examined	Number sprouted		Height of tallest mm.		Height of shortest mm.	
	Coarse	Fine	Coarse	Fine		Coarse	Fine	Coarse	Fine	Coarse	Fine
Nov. 10	10	10	12	12	Nov. 15.	0	2				
					Nov. 16. 8 A. M.	1	7				
					Nov. 16. 11 A. M.	2	9				
					Nov. 17.	3	9				
					Nov. 18.	3	9	47	71	3	37
					Nov. 22.	4	9				
					Nov. 28.	4	9	90	122	5	70
Oct. 26.	6	6	20	21	Nov. 7.	0	1				
					Nov. 9.	0	1				
					Nov. 12.	0	2		21		13
Oct. 26.	6	6	70	70	Nov. 9.	0	0				
					Dec. 12.	*	†				
Oct. 27.	4	4	8	8	Nov. 9.	1	0				
					Nov. 17.	1	0	120			
Nov. 17.	4	4	8	8	Nov. 22.	3	2				
					Nov. 28.	4	2	67	65	25	63
					Dec. 12.	4	3	95	80		55
Oct. 27.	2	2	8	10	Nov. 22.	0	2		60		32
					Dec. 12.	0	2		100		97

* No roots. † One with roots 40 mm. long, another 23 mm.

THE BAR ENCROACHING ON THE MARSH.

In 1885 Albert Judson, county surveyor, found that the west line of Huron Township had shortened "twelve rods" since the original survey made by Almon Ruggles in 1807. Near Rye Beach he found the shore had moved landward about "twenty rods." A survey made by Rolla Chase in 1903 at the eastern border of Rye Beach showed the lake had there encroached on the land about 25 rods since 1816. The marsh at the outlet of Sawmill Creek, just west of Rye Beach, formerly extended out where the lake is now. The present marsh is well filled with living buttonbushes. In the lake on the other side of the bar the roots still stand where buttonbushes formerly grew. They have been seen as far out from the present shore as "fifteen rods." Some may also be seen projecting through the sand of the bare beach and one of these was noticed with green leaves. The cut bank and a few undermined trees show recent encroachment of the lake on the part of the bar extending from Rye Beach a little more than a mile. Some of the sand and gravel washed out has been carried over onto the marsh as may be seen in a number of places; more of it has probably been transported along the beach toward the northwest.

At the mouth of the Black Channel I found that on the bar near the bay shore the auger after being turned through three or four feet of sand could be pushed to a depth of ten feet below water showing that here the bar had encroached on the marsh. This was Dec. 27, 1901. Attempts made the following month at four other places on the bar were unsuccessful in finding muck. In one of them the auger after boring 8 feet through the sand was stopped by a pebble or other obstruction. In the others it was turned after much labor to a depth of 11, 13, and 18 feet, and pulled out with improvised levers and in the case of the deepest a little turning. This led me to doubt whether the whole bar had moved onto the marsh. However, Jan. 28, 1905, I found a place in the marsh several rods from the bar where so much sand was mingled with the muck as to make it impossible to push the auger through it. The same day we succeeded in pushing the auger through several feet of muck beneath the bar a little less than two miles from Rye Beach. This convinced me that at the places where I had failed to find muck, the reason was that it had become so filled with sand as to prevent pushing the auger through it. In one at least of the places where trial was made Jan., 1902, the sand brought up was blackened with organic matter.

At the Carrying Ground the bar rests on marsh muck and the muck extends out under the lake at least 38 rods, probably much farther. At one place the muck under the bar was found to extend to a depth of 18 feet below water level. In the lake 30 rods from shore the muck extends to a depth of 10 to 13 feet along a line parallel to shore more than 60 rods in length. In the deepest place it doubtless is quite as deep as under the bar, 18 feet, though where borings were made, the clay was not more than 13 feet from the surface.

Much of this submerged bog had but a few inches to a foot or two of sand over it when I examined it in February and March, 1904.

At two or three places in the lake between the Carrying Ground and Rye Beach unsuccessful attempts have been made to push the auger after turning it some distance into the sand. A little more than two miles from Rye Beach the auger was turned down to 9 feet below top of ice and turned more easily the last two feet than nearer the surafce, as if the muck still remained, but with sand enough in it, to prevent pushing the auger through it. In driving stakes for fish nets more than a hundred rods off shore a mile and a half or so southeast of the mouth of the black channel Captain Steible tells me they used to strike what they believed to be muck. A large blunt stake would rebound and penetrate but little at each blow. This was where the water was sixteen feet or more in depth. He has seen along the beach when the water was low a sheet of muck two or three rods long. The sand usually prevents one from seeing any muck until it is washed ashore.

In the season of low water from 1891–1901 there was probably no encroachment on the marsh excepting that produced by the wind, and the trees along the shore of the marsh show that there has been no general encroachment for several decades. But the northeasters at time of the high water of 1858–1862, swept away the trees, and moved the whole bar over onto the marsh. Allen Remington remembers one cottonwood in particular, which served as a landmark for fishermen, much larger than any tree now on the bar. It stood not far from the mouth of the Black Channel and about 1856 was nearer the bay shore but when he began fishing, 1859, was about midway between the bay and the lake. In a few years more the beach had moved to it and it fell into the lake. At the point where this large cottonwood stood the encroachment on the marsh prior to 1857 could not have amounted to much during the life of this tree, else the shore of the marsh would have been farther from the tree but the fact that throughout much of the length of the bar there were no large trees probably indicates that it had not remained stationary for a great length of time.

Later than 1864 John Steible used to tie his boat to large stumps in the lake about where Remington's cottonwood stood. He remembers a three-foot cottonwood that stood a short distance southeast of the Carrying Ground and a few other large ones near it but no large trees of any sort on other parts of the bar.

Openings Through The Bar.

At times of very high water openings have been made through the bar deep enough for the passage of fishing boats. According to Jacob Barker there was an opening in 1838 at what he called the lower carrying ground at or near the mouth of the Black Channel. The high water of 1858–'60 raised by northeast gales washed over the bar throughout its whole length. About 1858 Palmer Jackson witnessed the rapid enlargement of an opening at the Carrying Ground. When first seen it was about ten feet wide, but in half an hour had widened to twenty rods and later to more than a quarter of a mile. Many willows and other bushes were swept away. In the spring of 1859 the high water cut through the bar about 2½ miles from Rye Beach, i. e., a few rods west of the east line of section 4 of Huron Township. Allen Remington remembers this as being open all that season. James Galloway thinks it remained open four or five years. He says it was about thirty feet wide at the top and deep enough in the deepest part for a pound boat. The correctness of the location as given by him is confirmed by the fact that near the spot he assigns I found in the marsh several rods from the bar so much sand mingled with the muck as to prevent pushing an auger through it. Captain Steible recalls an opening at or near the same place about 1867–'69 though it was not open for about three years after he began going there, i. e., 1864. On the lake side it was choked with sand and re-opened a number of times. The Clarks who used to haul their fish along the beach to Huron were prevented for some time by this opening. He has seen the water go over the bar for its entire length. He built a breakwater to prevent his fishing shanty located on about the highest ground from being washed away. The water covered the floor of the shanty a number of times. He says the bar is higher now in many places than it was then.

About 1876 or 1878, also years of high water, an opening was made through the bar near the southeast end of the Carrying Ground. Through this Jacob, Henry and John Lay, who had nets in the lake, passed several times with a pound boat. It was formed by a severe northeast storm in the spring, the water going over the bar for a mile or more. It remained open at least till some time in the summer but was closed again in the fall and reopened a year or two later. The sand point projecting into the bay at the west line of Huron Township is supposed to have been formed by sand washed through an opening. In the bay near this point the muck extends to a depth of twenty feet. A few centuries ago two small streams united a short distance to the southwest of this point as shown by borings in the marsh. The valley of the united streams passes under the bar at this point. (See Map V.) In the bay near by is sand overlying the muck and probably brought in through the opening. Jacob Lay remembers the opening of 1876 or '78 as being near this place, but others say it was farther northwest.

Since 1878 I think there has been no opening through the bar except at the mouth of Sawmill Creek near Rye Beach which in time of flood sometimes forms an outlet into the lake which soon becomes choked with sand like the mouths of all the small streams entering the lake and, it is said, even the mouth of the Huron River in the early part of the 19th century.

The Carrying Ground, as it is generally known in Sandusky, is at the northwest extremity of the bar. The Indians and later the white fishermen used this as a portage, for it is narrow and low and conveniently located for reaching from the lake either Sandusky or the mouth of Pipe Creek. Prior to 1875 whenever the wind was not fair for sailing around Cedar Point, the fish which were often caught in the lake in large quantities were carried across here and much labor and trouble saved thereby. At that time the pound boats were smaller than now and not so well adapted to beating around the point. Until about three centuries ago Pipe Creek had its outlet here.

DUNE SECTION OF CEDAR POINT.

This part of Cedar Point extends from the Carrying Ground to the head of Biemiller's Cove, a distance of two miles. Its topographic features are to be shown on a revised edition of the Sandusky sheet published by the U. S. Geological survey. Underlying it the clay, deposited when a glacial lake still covered the whole region, has its upper surface but little below the present water level. Here there has been land ever since the disappearance of that ancient lake, known as Lake Warren, caused by the retreat of the glacier. Until less than three centuries ago this land was connected with Sandusky by a strip of land lying north of Pipe Creek as shown by borings. (See Map V.) It is not, like the bar, a mere wave built formation. Its breadth and its irregularities are due, in part at least, to the surface of the underlying clay which had been modified by subaerial erosion when Lake Erie was yet at a distance. This erosion, moreover, must have been held in check in so level a region by the proximity of the underlying rock which in parts of Biemiller's Cove is less than 12 feet below the mean lake level of recent years.

BIEMILLER'S COVE.

Biemiller's Cove does not represent a valley in the clay but the crest. At one point the clay was found immediately under the ice and extending down to rock less than nine feet lower. At another point it was less than three feet from the surface. About sixty rods from the north end the clay is covered with some ten feet of muck. Several centuries ago, before the lake had attained its present level sand and gravel were piled up along the northeast shore of this land and the bay formed smaller deposits on the southwest shore. In time the water became high enough to cover most of the land between these deposits, forming a marsh both margins of which have since been covered by the sand. Near the cove and northwest of the Lake Laboratory the roots of large trees and an old cedar stump still retain about the same relation to the surface as when the trees started two or three centuries ago. A scow run ashore south of the Lake Laboratory about 1881 shows no appreciable change in the shore since that time. But in driving pipes for the Laboratory well, 1903, Mr. Appell found that after the point was down 12 or 14 feet below the surface of the ground, it drove the next 18 inches or so very easily, and after that hard again. When the point was in the part where it went down so easily he pumped up water that was dark colored, containing fibers as if from a marsh or bog. How much farther east this marsh extended I do not know. On the other side of the cove just inside of the bar and nearer the head than the mouth of the cove I found beneath a few inches of marsh at the surface some three or four feet of gravel and beneath that about four feet of muck. This narrow part of the peninsula that shuts in Biemiller's Cove appears to be a wave built bar connecting the wider part toward the end with the land at the head of the cove. In the wide part the clay must be near the surface; at least I have found it near the surface at several points in the bay not far away and inside the cove a short distance from it.

The terminal portion of this peninsula has been built up by the bay in recent years; it appears to have extended about 18 rods in 1904 and double that amount since the survey made by the War Department in 1872. In the survey of 1826, however, it extended a quarter of a mile farther than in 1872. (See Map I.) A map "60 years old" representing Cedar Point as divided into city lots shows two islands off the end of this peninsula and in line with it, named Big Sandy Island and Little Sandy Island. The water is still very shallow there.

The chart of 1826 shows the cove narrower and the land both sides of it much wider than now. Part of what appears on the chart as land must have been marsh. These changes have been produced mainly by the rising of the water but on the bay side of the peninsula land has been cut away by the waves. A number of trees were overturned in 1904. People remember seeing the same thing years ago along the lake shore not very far from the laboratory, and a chart issued in 1864 marks this shore "wearing away."

THE DUNES.

Irregularities of the original surface and the existence of trees and bushes have caused the wind to build up numerous sand dunes, the highest of which according to Kellerman is 27 feet. The other parts of Cedar Point having been built up anew are much more regular.

The sand which here has been heaped into dunes and the sand which in the terminal portion of the peninsula has been piled into ridges is from two sources.

(1st) It has been transported along the beach from Rye Beach and beyond, most of the pebbles, having been reduced to sand while in transit. Sticks tossed into the lake usually drift toward the northwest, though sometimes in the opposite direction. The movement of sand and other things along the beach is almost always toward the northwest for its motion is accomplished by the combined action of waves and shore current, the waves lifting the materials and the current carrying them forward. Waves on this shore are raised by an east wind and the accompanying shore current I believe is always toward the northwest. The crest of the wave is oblique to the shore and its left strikes first causing the water to rush along shore toward the right carrying the sand with it while the portion of the sand carried lakeward by the undertow is moved by the shore current in the same direction as that on the beach.

(2d) Sand swept out of the mouth of the bay by the rapid current is carried ashore on Cedar Point, some of it probably going nearly or quite to the Carrying Ground. Recently my attention was called to the existence of such an eddy by Lorenzo Anthony who long ago used to set fish nets east of Cedar Point. I recalled that a certain bottle which I had set adrift in the bay was found broken and among timbers at or near the Carrying Ground. This was Bottle No. 37A, dropped half way between Sandusky and the west end of Johnson's Island at I p. m., Sept. 26, 1902, and carried by the current into the lake and cast ashore nearly 3 miles from the lighthouse, where it was found the next morning at nine o'clock. Bottle 42A set adrift at the entrance to the bay went ashore on the lake side of Cedar Point about half mile from the lighthouse. Both of these must have gone out beyond the end of the jetty. A number of my bottles were dashed to pieces on the jetty. After Mr. Anthony told me of his observation, I had a bottle thrown in the lake beyond the end of the jetty; Captain Magle reported that he threw it near the can buoy. This was about 3 p. m., Dec. 3, 1904. Dec. 6, at 8:30 a. m., a man who had crossed the bay on the recently formed ice found the bottle on the lake beach more than two miles from the lighthouse.

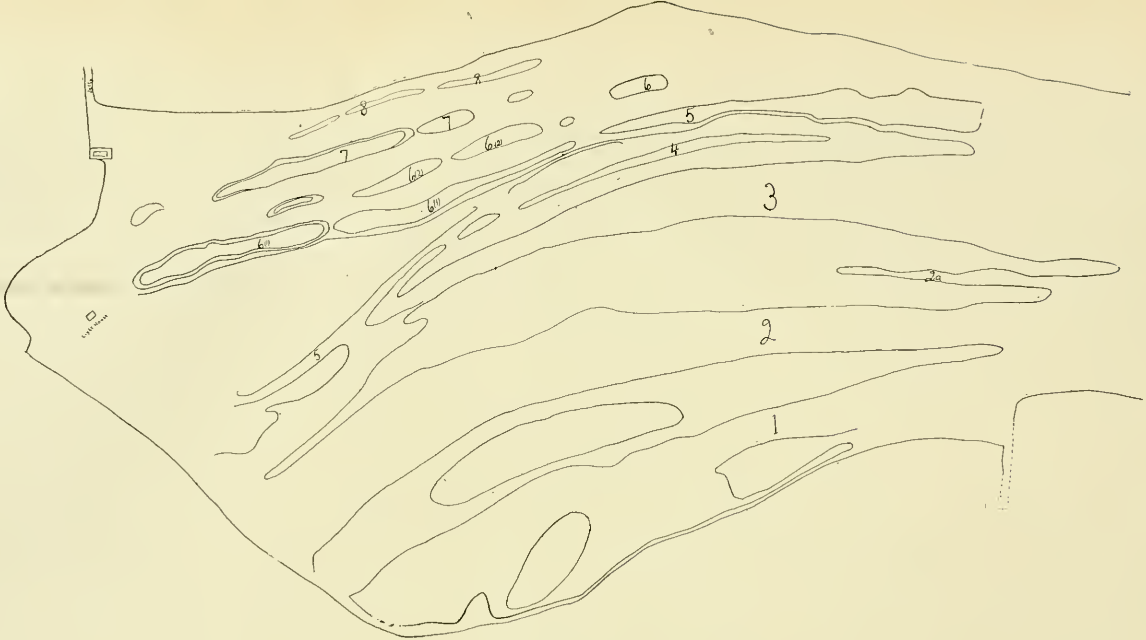
Part of the sand brought ashore by such a current may have come originally from the vicinity of Huron, having travelled the whole length of the beach, in and out of the bay a number of times and then ashore on Cedar Point again some where between the Carrying Ground and lighthouse perhaps to be pushed along to the end again and go the rounds once more. It would be interesting to know how many times some of the grains have taken such a journey. Another part of the sand which is swept out of the bay originated at Marblehead. This of course becomes mingled with that from the southeast.

The wider beach along this part of the peninsula gives the wind more opportunity to take up sand, while its fineness caused by long attrition favors its transportation by the wind.

RIDGE SECTION OF CEDAR POINT.

This is the terminal portion of the peninsula, extending from the end to Biemiller's Cove, about one mile. Its maximum width is over half a mile when the water is low but less when it is high. It is made up of parallel ridges which have been built up by the lake and consist of beach gravel and sand. It contains no clay or rock near the surface. At the power house clay was found about 23 feet below lake level and rock 46 feet below. Farther north both are probably deeper still.

In crossing this part of Cedar Point not very near either end eight ridges are easily distinguished. Towards the end, especially the south end, are others which do not extend so far. These eight ridges I have numbered beginning on the bay side. In describing them, however, I will begin with the most recent.



MAP VII.

Ridges of Cedar Point.	Contour line of
Ridge 1,	2 feet above Lake Erie.
" 2,	2 " " " "
" 3, s-w side,	2 " " " "
" 3, n-e side,	4 " " " "
" 4,	4 " " " "
" 5, n-w part	2 " " " "
" 5, s-e part	8 " " " "
" 6,	8 and 10 " " " "
" 7,	8 and 10 " " " "
" 8,	4 " " " "

The ridges are not interrupted but in places descend a little below these levels so that these contour lines make them seem broken.

Recent Ridges.

Ridge 8 extends along the lake to within 36½ rods of the Beacon Light at the inner end of the jetty. It is only three or four feet higher than the valley behind it, but is growing. Its crest is well covered with cottonwoods whose lower branches are partly buried in the sand and whose tops rise only eight feet above it. Several of these cut with a jack knife showed five rings. It has evidently formed since the jetty was begun, Oct., 1896, and probably because of the accumulation of sand produced by that obstruction. At the north end is a group of cottonwoods 11 to 14 feet tall. These may have been a factor in determining its location. Besides cottonwoods Ridge 8 has a number of small willows, but no other trees.

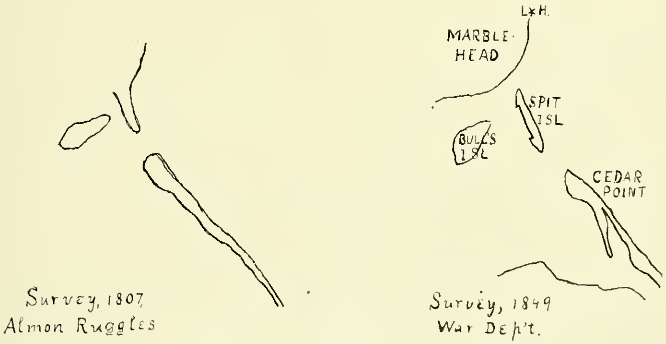
In the valley behind Ridge 8, is a conspicuous line of driftwood and many fragments of coal from wrecks marking the place where the waves came before this ridge was formed.

Ridge 7 is longer, broader and higher, rising 12 to 16 feet above the lake. Its crest is covered with cottonwoods 35–50 feet tall growing almost to the exclusion of other trees. In one spot are several buttonwoods 12–17 inches in circumference. There is a willow (Salix amygdaloides) 17 inches in circumference quite a number of white ash, the tallest 6 feet, an oak and a maple less than 2 feet. Two cottonwoods were found with a circumference of 37 inches. One of them 52 feet tall was cut three feet from the ground and 21 rings counted. As the section was 3½ feet above the roots and the inner circle thick, three or four years may be added in estimating the age, making it 24 or 25 years. Ridge 7 has no trees much older than this. It probably originated in 1878 the year of maximum rainfall at Cleveland and Buffalo. This is the year in which a ridge was formed on the Marblehead Sand Spit on the other side of the entrance to Sandusky Bay from Cedar Point according to a fisherman who lived there. On September 11, 1878, occurred the great storm described in the first chapter. No doubt this or the storm of August 15, 1879, probably both, were instrumental in the building of this high ridge. Cottonwoods started on it in 1880 and were not all destroyed by the great storm of April 23, 1882, but their roots more deeply covered. The ridge was then finished so far as the work of the waves was concerned.

In the valley behind ridge 7 and resting upon the base of ridge 6 is a line of driftwood, some of it rotten. In it were found a cleat of a boat and a large cinder or clinker. There are also shells of clams and other mollusca that live in the lake. Shells and coal were found both on and below the surface, a fish bone below the surface.

Ridge 6 resembles ridge 7 in breadth, height, and vegetation but the trees are larger. Its southern portion is single but toward the north are two ridges of about the same age which I have designated 6 (1) and 6 (2), the former being the highest of all the ridges, in one place nineteen feet. These will be included in any reference to Ridge 6. Here too cottonwoods predominate over all else. One locust (Robinia pseudacacia) is 37 inches in circumference and about 62 feet tall. White ash is perhaps ten times as numerous as on Ridge 7, the tallest about 18 feet, but most of them less than 12 feet. There are several cedars 10 feet or less in height and a very few trees of other kinds. Most of the cottonwoods are not much more than a foot in diameter but two were found 55 inches in circumference One of these near the big locust was cut and found to have been 64 feet tall and to have 41 or 42 rings about 3 feet above the roots, indicating an age of about 44 years. This Ridge was doubtless formed at the time of the high water 1858–62, probably by the same storms that swept the trees from the bar and moved the bar over onto the marsh. The oldest trees on the bar appear to be of about the same age as those on Ridge 6. In the valley between 6 (1) and 6 (2) we found clam shells, decayed driftwood and peat such as one finds on the present shore. A few inches below the surface in a thin layer of organic particles such as one finds at the margin of littoral pools we found pieces of coal and cinders. As late as 1866 steamers entering Sandusky Bay with coal smoke issuing from their funnels attracted some attention, for most of the steamers burned wood. This shows that Ridge 6 (2) which must have been formed after the coal and cinders had been washed ashore is not much older than 1859. Ridge 6 (1) may have started in 1857 or 1858 and have been completed in 1859 while Ridge 6 (2) may have been built by the great storms of 1861 and 1862. This part of Cedar Point was surveyed for the War Department by Lieutenant Colonel Graham in 1862. The shore line shown on his chart is farther northeast than it was in 1849 when the last survey previous to 1862 was made. In a map illustrating a report on Sandusky Harbor by Colonel T. J. Cram, U. S. Engineer, 1864, taken partly from Graham's survey in 1862 the northeast shore of what I have called the dune section of Cedar Point is marked "wearing away." Doubtless much of the sand removed from that section was built into these ridges. Besides, sand derived from dunes lately demolished on the other side of the channel after being swept into and out of the bay must have found a resting place here.

Before proceeding to consider the age of the older ridges it may be well to draw some further inferences regarding these that were formed in the 19th century. The mode of formation is probably as follows: A great northeast storm occurring at a time of high water piles up the sand to a height which is beyond the reach of the ordinary storm or a great storm occurring when the water is not above its ordinary level. In the spring numerous seeds from the cottonwoods that grow in such profusion on the ridges farther west are wafted by the wind to the newly formed ridge or possibly cast upon it by the waves, after falling into the lake. Here they have sufficient moisture, yet the roots are never below water level. As they grow they help to hold the sand that is blown by the wind and other sand that may be tossed up by the waves of other great storms, so that their roots are soon deeply buried. The willows too send their seeds in good season to take possession of the new land but they cannot muster so



Map VIII.

large a force as the cottonwoods and being unable to grow as fast are left in the shade, while the sand accumulates so fast that they cannot keep their heads above it. After the ridge reaches its full height seeds lodging on its surface cannot get moisture enough. So the cottonwoods are left in undisputed possession. When they have grown so large that birds frequent them or roost in their branches the seeds of poison ivy and other vines are dropped and germinate. The dead leaves begin to accumulate over the sand and form a mulch. A few herbs spring up and help the vines to keep the dead leaves on the ridge. The wind brings keys of the white ash and birds drop seeds of red cedar and some of these find moisture enough to enable them to grow.

CEDAR STUMPS.

In determining the age cf most of the older ridges I have depended on data furnished by cedar stumps. Several points must be considered. 1st. The ridge was formed probably nearly or quite 40 years before cedars started to grow on it. Ridges 8 and 7 have no cedars. Following ridge 6 a certain distance, Fred Lay counted 13 cedars, all quite small, and returning to the starting point along Ridge 5, he counted 160. On the bar, which has cottonwoods over 40 years old, are no cedars although it is nearly 5 miles long. On the Marblehead Spit which has formed northeast of Johnson's Island since 1858 the only cedar is one that is said to have been planted. 2d. The large cedars on Cedar Point were cut more than half a century ago. Mr. Samuel Catherman who came to Sandusky in 1835 says "right along after that cedars were cut on the Point; there was quite a business of cutting and transporting them to Sandusky, where all the fence posts were cedar and the frames of quite a number of houses, some of them still standing. The wood was used also for other things. Most of the largest ones had been cut by 1850 or about that time." Mr. Louis Adolph, who came in 1863, says, "they had been cut long before that." Captain Freyensee remembers that in 1849 or 1850 in a warm day in January he helped load a scow with cedar posts about half way between the present dock of the Cedar Point Company and the U. S. Government dock. The yawl used to carry the posts out to the scow was loaded so high that it turned over spilling the posts with him into the bay. He does not remember seeing cedar timber brought from Cedar Point after that. According to John Homegardner, Sr., and others the last of the large cedars were removed from Cedar Point by D. C. Richmond who used them for posts on his farm where they have remained sound to this day. This was in February, 1850. One of the men employed in the work was drowned. Mr. Homegardner too says, "they began taking them from the Point as early as 1835." Dan Myers came in 1852. He says "some cedars were cut in 1853 or '54. Probably these were not among the largest. 3rd. After counting the rings on a stump a number equal to five-eighths of the number of rings in the outer inch is added on account of the sap wood that has rotted away. 4th. The largest stumps are hollow and in estimating their age it is not right to assume that the number of rings to the inch in the missing portion was about the same as in the portion remaining. As a general rule the number to the inch increases toward the outside, though this is not very noticeable in small stumps;

in some of them the reverse is true. If the stump has a large hollow, estimates of its age are probably not very close. If the hollow is larger than in other stumps of similar size growing near, it is perhaps an indication not of greater age but of more rapid growth. If the stump is on low ground I think it is more likely to be hollow and Bartelle Reinheimer who has assisted in count-the rings has observed that stumps on low ground average fewer rings to the inch than those on higher ground. Doubtless the character of the wood and the abundant moisture both contribute to hasten decay. Many of the medium sized stumps are still nearly sound. For the first four inches from the center the number of rings averages about 13 or 14 to the inch and for the next four inches about 17 to the inch. Near the outside of one large stump 59 rings were counted in a single inch.

Old Ridges.

Ridge 5 back of the new hotel rises 13 feet above the lake, being higher than any of the ridges farther west. The theater, main pavilion and several other buildings stand upon it. Toward the northwest it diverges from Ridge 6 (1) giving room for a swamp containing a small pond. Although low in this part it is distinctly traceable to the vicinity of the lighthouse. Upon it is the rankest growth of poison ivy and other vines and an abundance of scouring rush and False Solomon's-seal. The cottonwoods have attained to old age and many other trees have grown to considerable size—black oak, white pine and basswood, more than 5 feet in circumference, white ash, red elm, sycamore and willow (Salix amygdaloides) more than 3 feet. Several of the cottonwoods exceed 8 feet in circumference. One measuring 111 inches was broken off probably by the wind, not less than 18 years ago according to Chas. Baetz. Where broken it is rotten but by chopping to the center of it 15 feet from the roots we were able to count about 141 rings. Allowing 10 years for the first 15 feet of growth we conclude that this tree started about 170 years ago. A few other cottonwoods are larger and were likely larger when this ceased growing. The living cedars on this ridge do not exceed ten inches in diameter but there are a few stumps a foot in diameter. On one of these 85 rings were counted. Another a little larger was not in such condition that the rings could be counted. It was probably but little older. Adding 90 to the number of rings counted for reasons given in a preceding paragraph we conclude from this cedar stump that Ridge 5 is not much less than 175 years old. It is likely older but probably not 200 years. We will take 180 years as its approximate age.

Ridge 4 is not very distinct from Ridge 3 toward either end but throughout the remainder of its length well defined, though rising only four or five feet above the valley on either side and only about four rods wide. It may be easily found by going west from the new hotel, "The Breakers," across Ridge 5, which is much higher. Its cedar stumps are but little larger and older than those on ridge 5. I estimate its age as 220 years.

Ridge 3 is ten or twelve rods broad and has an undulating surface. The power house and a number of other buildings stand upon its southern portion. In places it looks as if formed of two parallel ridges so close together as to be distinguished with difficulty. It has a rich vegetation—herbs of great variety and large trees of many kinds. It has ten cedar stumps 20 inches or more in diameter, three or four of them being about two feet. The age of the older ones has been estimated at 163, 165, 194, and two, less carefully determined, about 210 years each. Ridge 3 is probably about 310 years old.

Ridge 2 is situated between the two lagoons. It has large trees of various kinds, including black cherry which would not start until the soil had become enriched. It has many cedar stumps about 20 inches in diameter and two that exceed two feet. On one of these 26 x 27 inches, I counted 189 rings in the outer ten inches. Nearer the center of growth indicated by a knot, most of the wood has disappeared but some chips showed 8–16 rings to the inch. Allowing 13 rings to the inch the remaining 4 inches would add 52 rings, the sap wood 15, making a total of 256. On account of its size and location it was probably among the earlier cedars to be cut. Adding 65 years for this and 40 for time elapsing after formation of ridge before this tree started we have a minimum age for Ridge 2 of 361 years, but it is older than that. Ridge 2A, low and narrow, lies to the northeast of Ridge 2 and terminates about one-sixth of a mile from the cement walk. It has two stumps larger than any on ridge 2. One of them, 37 x 37 inches is probably the oldest stump on Cedar Point. When discovered, Oct. 22, 1904, I estimated the age as about 300 years. Feb. 19, 1905, I visited it again and made a more careful estimate. I found about 80 rings in the outer 3½ inches, the remaining portion being too much decayed to admit of counting many consecutive rings. The average of four fragments taken from different parts of the decayed portion was 13½ rings to the inch. This with 15 years for sap wood gives an age of 297 years. Ridge 2A, therefore, cannot be much less than four hundred years old, and as it was formed after Ridge 2, we will call the age of Ridge 2 four hundred years.

Ridge 1, on which the "White House" is located has many large black oak, American elm and other trees. Its cedar stumps are evidently older than those on Ridge 2, being larger and more decayed. Eight or more exceed 27 inches in diameter and four range from 30 to 36 inches. The ages of eight of the older ones were estimated at 185, 200, 220, 229, 236, 245, 261 and 262 years. The oldest, then, are but little older than the oldest on Ridge 2, and not so old as the oldest on Ridge 2A. It does not follow, however, that the ridge is only a few years older than Ridge 2 and 2A. In a forest that has been standing for centuries one is likely to find on five acres of ground one or two trees much older than any others of the same kind. Out of a hundred cedars starting at about the same time few live to be two centuries and ordinarily not one to be three centuries old. So the three-century cedar on Ridge 2A must be regarded as one that was exceptionally favored. The ten or twelve largest stumps on Ridge 1 appear to average fully six inches greater in diameter than the ten or twelve largest of Ridge 2. As these large stumps have an average of about 25 rings to the inch in the outer part we may take their average age as 75 years greater. The percentage of cedars to attain a diameter of 27 inches must be much less than of those that attain a diameter of 20 inches. It is therefore not improbable that Ridge 1 exceeds Ridge 2 in age by more than 75 years.

Number of Ridge	Name of Ridge	Estimated Age, Years.	Probable Error, Years.	Approximate Date of Formation.
1	Oak	475	50	1429
2	Cherry	400	25	1504
3	Cedar	310	35	1594
4	Pine	220	20	1684
5	Poplar	180	15	1724
6	Locust	45	2	1859
7	Buttonwood	26	2	1878
8	Willow	5	1	1899

BLACK SOIL.

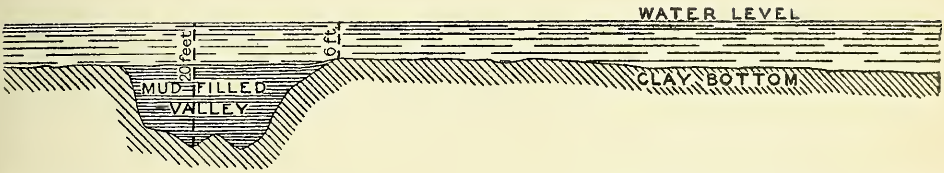
As we pass from the new to the old ridges, we notice a difference in the quantity of leaf mould that has accumulated. Ridges 8 and 7 have no covering of black soil. Ridge 6 has a little in places. On Ridge 5 it is about an inch deep, on Ridge 4, two inches, and on Ridges 3, 2, and 1, two to four inches or more. On Ridge 1 it is quite uneven, due, no doubt, to this ridge being so much exposed to the wind. The roots of many of its cedar stumps are well covered with sand.

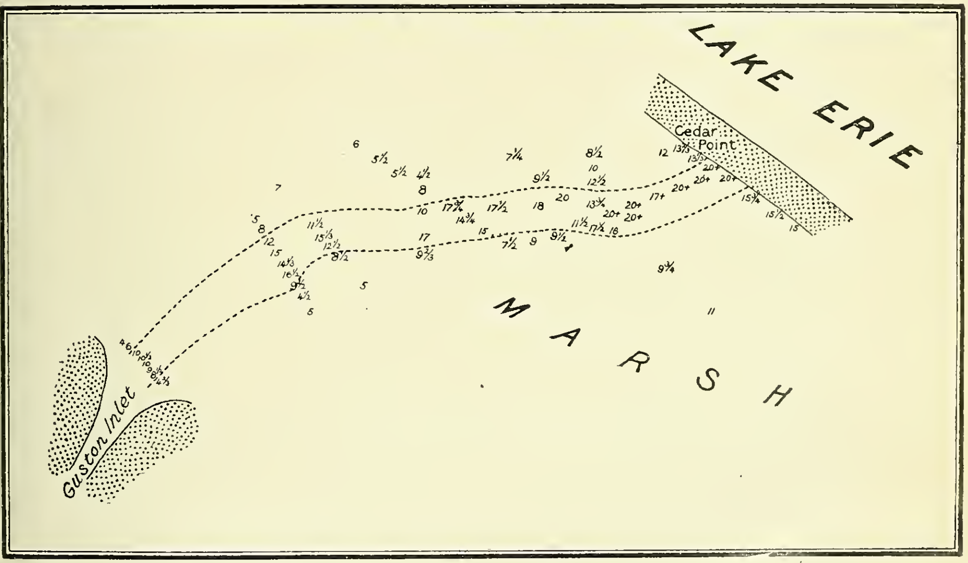
HEIGHTS OF VALLEYS AND OF AQUEOUS DEPOSITS IN RIDGES.

Soon after I began studying the ridges I noticed in going from the bay toward the lake a progression in the height of the valleys between them. In periods of high water the valley between ridges 1 and 2 could be traversed for quite a distance with a row boat and in very high water such as that of 1858 with larger boats. At such times it connected with the bay at its northwest end. This has been open once at least in the last 25 years. In October, 1904, it was opened by the dredge which made the lagoon in this valley and cutting through Ridge 2 made a lagoon between Ridges 2 and 3. Here also was water though not quite so deep as in the first valley. Between Ridges 3 and 4, and between 4 and 5, grow the swamp rose, cornel, and blue-joint grass showing that the soil is damp. Until 1904 I had never seen water standing in these valleys. All through the nineties the lake was too low but in 1904 a little water was visible at the surface between Ridges 3 and 5 beyond the northwest end of Ridge 4 and extending quite a distance. Between Ridge 5 and the lake the valleys are so high above water level that the sand is too dry for most plants and the scanty vegetation reminds one of the barren zone of the bar.

When I found that the ridges had been built up successively by the lake and that considerable time had elapsed between the formation of the earlier and later ones, it seemed likely that each valley might be higher than its predecessors because the lake itself had become higher than when the earlier valleys were formed. This hypothesis was strengthened when it was found that the valley behind Ridge 6, which was formed by the very high water that prevailed for some years prior to 1863, was higher than the valley behind Ridge 7, which was formed about 1878, and this higher than the valley behind Ridge 8, which was formed at a time of relatively low water.

Having noticed a progression in the heights of the valleys, it seemed possible that the aqueous deposits in the ridges them-





MAP IX.

East and west section one mile long, north of the western part of Sandusky, intersecting the submerged valley of Mill Creek.

Valley extending under marsh from Guston Inlet to Cedar Point, about a mile and a quarter. Thirty-three borings within the lines all show a greater depth to clay than the nearest ones outside.

selves might also ascend from the bay toward the lake. So the ridges were dug into in about 150 places altogether with a view to finding the highest trace of water action in each. The accompanying table gives the result, the data being reduced to mean lake level.

HEIGHTS OF PRINCIPAL RIDGES AND OF VALLEYS SOUTHWEST OF THEM.

Number of Ridge.	Approximate height of valley southwest of ridge, feet.	Highest aqueous deposits found	Height of aqueous deposits above valley.
1		2 .66	
2	−3.	4.55	7.55
3	−2.5	5.4	7.9
5	1.5	9.4	7.9
6	4.5	12.13	7.63
7	3.3	11.35	8.05

DEEPENING OF LAKE ERIE.

As each of the principal ridges was formed by a great northeast storm occurring at a time of high water the progression in level from the older to the higher is due to an elevation of the level of Lake Erie compared with the land. The approximate rate of change is determined by dividing the difference between the heights of the aqueous deposits in any two of them by the number of centuries intervening between their formation. Each ridge higher than all those to the southwest of it was probably formed by one of the greatest if not the greatest storm of the century or one that was more potent than others because of the high water at the time of its occurrence. That they were formed under similar conditions is evidenced by the fact that in each the highest indication of water action is about 7½ or 8 feet higher than the valley behind it. The accompanying table shows the rate of subsidence based on a comparison of the older ridges with Ridge 6, the highest. Ridge 3 gives a rate considerably higher than the others. It may be that it was not formed at the time of the highest water that occurred for many years, though at a time of high water. If we compare it with Ridge 7 we get a rate of 2.1 feet per century, which closely approximates the rate obtained by comparing the others with Ridge 6. It is quite possible that Ridge 3 is older than I have estimated.

On some of the recent ridges are aqueous deposits at a higher level than that at which the main roots join the trunks of the trees, indicating that the ridge was not the work of a single storm. If these deposits were left long after the trees started they would vitiate the results shown in the table. I have found no evidence that they were left long after and in the case of Ridges 2 and 6, it is certain that they were not, because new ridges were soon formed in front of each. The percentage of probable error in the determination of the age of Ridge 2 is less than in the other old ridges. It is old enough to give a long time interval. The rate based on comparing it with Ridge 6 is near the mean of the rates based on other comparisons. For several reasons then it may be regarded as the best.

RATE OF SUBSIDENCE OF THE LAND BASED ON A COMPARISON OF HEIGHTS AND AGES OF OLDER RIDGES WITH RIDGE 6.

Number of Ridge	Maximum h'ght of aqueous deposits, feet	Approximate age, 1904	Older than Ridge 6	Lower than Ridge 6	Change of level feet per century
1	2.66	475	430	9.47	2.20
2	4.55	400	355	7.58	2.14
3	5.4	310	265	6.73	2.54
5	9.4	180	135	2.73	2.02
6	12.13	45			

The scarcity of gravel in all the later ridges and the valleys between them is in marked contrast to its abundance in and between the older ones. Ridge 4 and those more recent contain but little gravel; ridges 6, 7 and 8, probably not a hundredth part as much as ridges 1 and 2. It is scarce also along the present lake beach, but on the bay shore the old gravel deposits have been exposed by recent erosion. When the older ridges were formed the hardpan overlying the rocks of the Dune Section and containing an abundance of pebbles and boulders was in reach of the waves; but when the later ones were formed the lake had attained a higher level and the hardpan was too far below the surface to furnish more material. Most of the sand in the recent ridges and present beach has either been transported many miles from the southeast or carried by currents at the mouth of the bay.

The extension of Cedar Point lakeward and the formation of so many ridges in the last half century is probably due to the washing away of Peninsula Point on the other side of the entrance to the bay, the material being derived largely from that source.

Surveys show the width of Cedar Point from Rosebush Point to the lake to have been about 2350 feet in 1896, about the same in 1872, and about 2340 feet in 1826. If these measurements are correct the bay has worn away about as fast as the lake has built up. The jetty begun in 1896 and not completed for several years has already caused the accumulation of many acres of sand.

CONCLUSION.

LOOKING BACKWARD.

The broad and shallow rock valley occupied by Sandusky Bay was formed partly by preglacial, partly by glacial erosion. Upon the retreat of the glacier the greater part of this valley was filled with glacial clay nearly or quite to the present water level.

When the melting of the ice made an outlet to the east for the glacial lake, Lake Erie was established. At first it occupied only the eastern part of the basin it now occupies. The Sandusky River then flowed much farther than now, cutting a valley in the clay. Its tributaries also made valleys. The depression of the west end of the Erie basin relative to the point of outlet caused the lake to extend westward. In time slack water extended up the valley of Sandusky River as far as the present entrance to Sandusky Bay. The depression of the land continuing, marshes were formed along the river and its tributaries and after a time the water southeast of Johnson's Island had become so deep and wide that the waves cut away the clay between the valleys. The bay thus started was enlarged both by the rising of the water and by wave action, the latter proceeding more rapidly as the enlargement went on.

The rising of the water has continued with a nearly or quite uniform rate—about two and one-seventh feet a century—for at least four centuries. If the rate was about the same during the preceding centuries we may conclude that at the beginning of the Christian Era slack water extended up the Sandusky River valley as far as Johnson's Island. Fifteen hundred years ago it extended up the valley of Mill Creek about a mile and a half from its junction with the Sandusky River south of Johnson's Island and to within a mile and a quarter of the present mouth of Mill Creek. The islands of the Put-in-Bay group were still part of the mainland. Until about a thousand years ago the Indians might have walked from Sandusky to Kelley's Island at any season, having merely to swim across one or two streams and wade through some marsh. East of Johnson's Island the river may then have been as wide as the Portage west of Port Clinton is now.

Before America was discovered the shore of Lake Erie was where Cedar Point is now, and at the time of the discovery was not far from Ridge 2 between the two lagoons. By this time Sandusky River valley had probably become wide enough south of Johnson's Island to form quite a bay, which, however, extended less than two miles west of the island, though slack water and marsh continued several miles farther.

When Jamestown was founded Pipe Creek and the streams beyond still entered the lake and not the bay. The land was as yet continuous from Cedar Point to Sandusky. West of the Bay Bridge was considerable marsh but little or no open bay.

In the eighteenth century the bay was known to French traders. A French map of "Louisiana and the Course of the Mississippi" dated 1718 was exhibited by the government at St. Louis in 1904. It shows Lac Sandouské. Other maps made in the eighteenth century also call it a lake. They show a narrow opening into it from Lake Erie. The American Gazeteer, 1797, says: "Sandusky Lake or Bay at the south-western side of Lake Erie is a gulf shaped like a shoe, and entered from the lake by a very short and narrow strait." None of the maps of the eighteenth century give the outlines with any approximation to accuracy. The first actual survey of the region south and east of the bay appears to have been made by Almon Ruggles in 1807. Map VIII shows a part of this survey, but Johnson's Island and the Peninsula, although shown on the map, had evidently not been surveyed.

Within the memory of Captain Freyensee and others still living bulrushes grew in all the water between Johnson's Island and the Peninsula and in some other parts of the bay where for many years has been open water.

Looking Forward.

One can never be quite certain as to future events. It looks as if the peninsula that separates Biemiller's cove from the bay, part of which has been land for thousands of years, would disappear in our own time. Now that the top of the clay has been reached by the rising water, the whole of Cedar Point may share the fate of Peninsula Point at no distant date unless jetties, piers, cribwork, etc., suffice to save it.

The bay with the connected marshes is probably twenty per cent larger now than in 1820. So far as the enlargement is due to erosion it should proceed more rapidly the wider the bay becomes, for the waves attain greater force. The effect of the waves, however, is diminished by the bay bridge, by jetties at the entrance to the bay, by docks and by stones put on the shore purposely to protect the land. The enlargement of the bay due to the subsidence of the land may be partly prevented by dikes and may be effected to some extent by changes at Niagara Falls produced by human agency. We may reasonably expect, however, that the bay will continue to spread over the adjacent lowland much as it has been doing for centuries past.

The rise of the water due to tilting of the land, 2.14 feet in a century, is about the same as the change of lake level that sometimes occurs within a year in consequence of variations in the rainfall and is considerably less than that produced in Sandusky Bay by a single northeast gale. It is, however, cumulative. The present generation is likely to see the water higher than it was in 1858 and in northeast gales the lower parts of Sandusky submerged, but at the present rate of subsidence the bay at ordinary stages of the water will not extend up Columbus Avenue as far as Market Street for about eight hundred years. Port Clinton is not so fortunately situated. Northeast gales will cause much trouble there as soon as there comes a period of several years when the rainfall is considerably above normal, and before the middle of the next century the water at such times will go quite across the peninsula from Port Clinton to Sandusky Bay. After two or two and a half centuries the water will cover this part of the peninsula for months at a time and after three centuries will do so at ordinary stages. Marblehead will then be an island and Sandusky Bay will show no resemblance to its present form.

Biology and Mathematics

DR. GEORGE BRUCE HALSTED

That which is most characteristic of the present epoch in the history of man is undoubtedly the vast and beneficent growth of science.

In things apart from science, other races at times long past may be compared to the most civilized people of today.

The lyric poetry of Sappho has never been equaled. The epic flavor of Homer, even after translation, comes down to us unsurpassed through the ages.

Dante, the voice of ten silent centuries, may wait another ten centuries before his maedieval miracle of song finds its peer.

The Apollo Belvidere, the Venus of Milo, the Laocoon are the glory of antique, the despair of modern sculpture. To mention oratory to a schoolboy is to recall Demosthenes, and Cicero, even if he has never pictured Caesar, that greatest of the sons of men, quelling the mutinous soldiery by his first word, or with outstretched arm, in Egypt's pălace window, holding enthralled his raging enemies, gaining precious moments, *time*, the only thing he needed to enable him to crush them under his dominant intellect.

There is no need for multiplying examples. The one thing that gives the present generation its predominance is science.

All criticisms of life made before science had taken its present place, or attempting to ignore its prominence are obsolete, as are of necessity any systems founded on pre-scientific or anti-scientific conceptions.

Now the latest of the great sciences is biology, and it could be so widely interpreted as to include many of the others, for example, physiology, psychology, sociology; but chiefly it takes for itself the broad general beginnings.

These older sciences were really engaged upon narrow domains, narrow ramifications in the universe of biology; and the general has helped the pre-existent special by giving the broader conceptions connoted by comparative physiology, comparative psychology, comparative sociology.

Since Woehler, the distinction between organic and inorganic matter has become merely schematic; but the line drawn at life has resisted obliteration

It is true that my friend, Professor Herrera has said:

"I conceive the human organism as a machine containing some five or six litres of blood employed in appropriating to itself the nutritious principles of food, absorbing oxygen, and carrying it to the nerve to make it vibrate by discharges of carbon-dioxide.

"Life is now to be defined as the result of the physico-chemical action of protoplasmic currents, the cause of such currents being diffusion, heat, and some other secondary factors."

But until someone sees such currents set up in some way differing from the natural transmission of pre-existent life, a thing which no one at present even hopes for, the old boundary remains undisturbed.

If any benefit is obtainable from a physico-chemical nomenclature and notation, science will not object to their use.

Suppose, then, we put it in the boldest form, that biology is now engaged in the creation of an available representation of the activities and laws of activity of these wonderful protoplasmic currents.

The definition then would be something like this: Biology is the science created to give understanding and mastery of the protoplasmic activities on this earth; to make easy the explanation and description of such activities and the transmission of this mastery.

The association, the suggestion is immediate:

Beyond the microtome, the microscope, the statistics of observation, of experiment, of what instrument of world-conquest must the new science avail herself? The answer is patent; of mathematics, that giant pincers of scientific logic which showed Newton the moon as simply a bigger apple trying to fall straight down on his head, flashed out in the mind of Adams the unseen planet Neptune, told Rayleigh that the chemists had always been breathing vast quantities of argon without knowing it, pointed to Mendeljeeff the places of unknown chemical elements, and through Helmholtz and his pupil Hertz has given us the Lenard rays, the Roentgen rays, radium itself, and wireless telegraphy based on Hertzian waves.

In mathematics, the part which is being recognized as pure deductive logic is ever greater. The residuum takes from biological advance itself new form and new statement.

After the questions, what are facts? what is reality? questions not to be answered either by biology or mathematics, there come, if we decide to retain as rough working hypotheses the expressions fact, reality, subsequent questions, such as what then is a *geometric* fact, a *geometric* reality?

These latter questions involve a wrestling with primitive origins in physiological psychology, now entangled with metaphysical constructions, all being studied at present with help of the biologically given hypothesis of evolution.

To note the essential inter-relation of biology and mathematics it is only needful to recall that evolution postulates a world independent of man, preceding man, and teaches the production of man from lower biologic forms by wholly natural causes.

If this be so, then skipping the fundamental puzzle as to how a living thing gets any conscious knowledge, any subjective representation of that independent world, it remains of the very essence of the doctrine of evolution that man's knowledge of this independent world, having come by gradual betterment, trial, experiment, adaptation, and through imperfect instruments, for example the eye, cannot be metrically exact.

In the easiest measurements it is said we cannot even with the best microscopes go beyond one-millionth of a meter; that is, we are limited to seven significant figures at most. What is the meaning then of the mathematics which, as in case of the evaluation of π, has gone to seven hundred places of significant figures?

If then we are to hold to evolution, science must be a construction of the animal and human mind; for example, geometry is a system of theorems deduced in pure logical way from certain unprovable assumptions precreated by auto-active animal and human minds.

So also is biology. But here the assumptions are more fluctuating, and many of them are still on trial.

Since every science strives to characterize as to size, number, and, where possible, spatial relations the phenomena of its domain, each has need of the ideas and methods of mathematics. One of the fundamental ideas of mathematics is the idea of variation, the variable, qualitative and quantitative variability.

When related quantities vary, one may vary arbitrarily, this is called the independent variable. Others may vary in dependence upon the first. Such are called dependent variables or functions of the independent variable. The change of the variables may be continuous or discontinuous. The blind prejudice for the assumption of continuity is so profound as to be unconscious.

But if biologists did but know it, the characteristics, peculiarities and methods of investigation for continuous functions differ essentially from those for discontinuous functions.

Our calculus assumed continuity in all its functions, and also that differentiability was a necessary consequence of this continuity.

Lobachevski, the creator of the non-Euclidean geometry, emphasized the distinction between continuity and differentiability, therein also being half a century in advance of his contemporaries.

The mathematicians of the eighteenth century did not touch the quetsion of the relation between continuity and differentiability, presuming silently that every continuous function is *eo ipso* a function having a derivative.

Ampere tried to prove this position, but his proof lacked cogency. The question about the relation between continuity and differentiability awoke general attention between 1870 and 1880, when Weierstrass gave an example of a function continuous within a certain interval and at the same time having no definite derivative within this interval (non-differentiable).

Meanwhile, Lobachevski already in the thirties showed the necessity of distinguishing the "changing gradually" (in our terminology: continuity) of a function and its "unbrokeness" (now: differentiability).

With especial precision did he formulate this difference in his Russian Memoir of 1835: "A method for ascertaining the convergence," etc.

"A function changes gradually when its increment diminishes to zero together with the increment of the independent variable. A function is unbroken if the ratio of these two increments, as they diminish, goes over insensibly into a new function, which consequently will be a differential-coefficient. Integrals must always be so divided into intervals that the elements under each integral sign always change gradually and remain unbroken."

In more detail Lobachevski treated this question in his work, "On the convergence of trigonometric series," in which are also contained very interesting general conisderations on functions.

"It seems," he writes, "that we cannot doubt the truth that everything in the world can be represented by numbers, nor the truth that every change and relation in it can be expressed by analytic functions. At the same time a broad view of the theory admits the existence of a dependence only in the sense that we consider the numbers united with one another as if given together."

Now biology deals largely with aggregates of individuals, and then, like the pure theory of numbers, its variables are discrete, and must change by jumps of at least one individual.

A mathematics proper to such investigations has not been accessible to the biologist, for not only has his calculus been founded solely on continuity, but also his geometry has been developed for him on continuity assumptions from the very beginning.

The very first proposition of Euclid is to describe an equilateral triangle on a given sect (a given finite straight line). It begins: "Let AB be the given sect. From the center A with radius AB describe the circle BCD. From center B with radius BA, describe the circle ACE. From the point C, at which the circles cut one another, etc." But the whole demonstration is the assumption of this point C. Why must the circles intersect? Not one word is given in proof of this, which is the whole problem.

You may say the circle is a continuous aggregate of points. If so, then the circle cannot represent a biologic aggregate of individuals.

Geometry can be treated without any continuity assumption, without continuous circles, in fact without compasses.

Such a geometry for biologists, is my own Rational Geometry, the very first text-book of geometry in the world without any continuity assumption.

How biology has been misled in its mathematics you will realize when you recall that geometry and calculus have been the basis of mechanics, mechanics the basis for astronomy and physics, physics the basis for physical chemistry, while even the theory of probability had no discontinuous mathematics specially its own.

Therefore biologists had clapped over their eyes spectacles of green continuity, and these spectacles colored biologic theories with the following characteristics as enumerated by the Russian Bugaiev:

(1) The continuity of phenomena;

(2) The permanence and unchangeableness of their laws;

(3) The possibility of characterizing a phenomenon by its elementary manifestations;

(4) The possibility of unifying elementary phenomena into one whole;

(5) The possibility of sketching precisely and definitely a phenomenon for a past or future moment of time.

These ideas make the very essence, the framework, the skeleton of modern biologic theories. They have forced their way in and imbedded themselves as being necessary to make possible the application of the methods of continuity-mathematics to the investigation of nature. They follow out the fundamental characteristics of continuous analytic functions. Therefore we may designate our modern biology as a continuity-biology.

Thus, as the Russian Alexeieff has pointed out, after the continuity world-scheme had captured the fundamental natural sciences, geometry, mechanics, astronomy, physics, chemistry, had intrenched itself in them and dowered them with generality, uniformity, universality, it went over gradually with scientific investigators by habit so to say into flesh and blood, and began to penetrate and dominate in physiology, in psychology, in sociology, in biology.

Darwin's attempt to found the law of the evolutionary origin of species is an outcome of the continuity world scheme, permeated, saturated with its basal idea, continuity.

Just so strengthens itself more and more the persuasion of the continuous growth and continuous perfection of all the elements of human society in its natural advance.

The evolutionary development of social life permeates always more and more the view of the historian. Many writers are so habituated to this continuity world-scheme, that without sufficiently critical consideration, they apply it where it is essentially inapplicable and inappropriate.

So we have the doctrine of a fatalist causality, denial of efficient freedom of the will, belittling of the idealistic endeavor of mankind, hence the pessimistic attitude toward the whole of human existence.

Paraphrasing a Russian poet, Nature thus speaks to man:

Thou mayst be head of creation,
But who gives thee any crown?
Dost thou believe, poor fool, in blind delusion,
That I am slave to thee, and thou my lord and master?
Of the thick veil lift I a corner tip
And pygmy, then presumst thou
All through me that thou seest?
Seeing thine own small law and plan, art then deluded
Into the holy of holies to have pushed?
Oh fool! I do but nod and wretchedly thou'llt shudder,
Cower like timid dog on the sod. The earth
I shake and suddenly is dust
Thy pride and might, the greatest of thy cities.
War I send and pestilence its sister,
The blooming fields transform I into deserts,
The sea I drink up and the sun shroud I in darkness,
And thou, brute-like, wilt howl with pain, with anguish.
What you strive for and hope,
To me that is indifferent.
Pity know I none, and my law of the number

Knows neither weal nor woe, knows
Neither praise nor blaming.
To unknown lands I stride in war, in whirlwind.
I know no aim, no end and no beginning.
I beget and I destroy, not prating, never angry,
The elephant and the worm, the
Wise man and the foolish.
So live as all live. Float out on the
Flood eternal
One instant brief, and vanish then forever.
Presume not stupid-bold with me to wage a contest,
With me eternal mother of all living and all dead."
So thunders Nature with a million voices
In hail, in surge, in storm-wind and the lightning.

So much for the continuity world-scheme in biology.

But the latest advances in mathematics have rendered unnecessary for biology the wearing of this mis-fit garment.

The new mathematics gives now a standpoint for the explanation and treatment of natural phenomena from which the individuality of the biologic elements need not be suppressed.

It has triumphed for its own domain in cases where the continuity methods were wholly inapplicable, where arithmology, discrete mathematics was called-for and victorious.

Such are the problems which relate to the properties of whole numbers, solved so brilliantly in number-theory.

Such again are the questions relating to the enumeration of the geometric forms within parameters which satisfy *n* given conditions. These even in the simplest cases showed themselves insoluble until finally between 1860 and '70 the French mathematicians created special discrete methods. Thence sprang a wholly new branch of mathematics, Enumerative Geometry.

A third, an epoch-making universe of discrete mathematics is the wonderful Invariant Theory of the great Sylvester and his brother-in-arms Cayley, two men whose loss left the English-speaking world without a single mathematician of first rank, of the rank of Hilbert and Poincaré.

In chemistry this discrete mathematics has shown itself of such use and power that we may assuredly say chemistry owes its present stand-point almost wholly to two lines of advance both discrete, the atomic structure theory of Kekule, and Mendelieev's periodic system of the chemical elements.

The brilliant and rapid advances in chemistry have come not from suppressing but from stressing the individuality of the elements. Its mathematics has been essentially discrete.

The arithmologic scheme of chemical research, the atomic structure theory of Kekule, coincides completely with the scheme of the symbolic invariant theory, though both were worked out independently.

Now to biology and sociology, having to do with single individuals differing from one another, in biology cells, in sociology human personalities, the continuity mathematics with its universalism is so ill adapted by its nature that the discrete way of thinking must here soon take the chief role, giving as it does large and free play to the individual peculiarities of the elements to be studied.

The continuity thought-way strives to reduce all phenomena of nature to a general mechanism with fate-determined movement. Just contrary to this then is the view that living nature is a rationally-correllated realm, in which everything is harmonic, shows adaptation, strives toward perfection.

Are not the mechanical form-phenomena of the living organism only its most elementary properties, upon which are built others higher, psychic? Now the psychic properties of a living organism cannot be studied by observation and comparison of the accompanying mechanical properties unless they flow from these mechanical properties. If these accompaniments be unessential, the psychic properties cannot be concluded from them. Here is even yet the battleground.

Biologists are at present emphasizing the statistical method, but upon this modern mathematics has for them another message. They rely upon the method of least squares and mean value. But Chebyshev has demonstrated that not the great number but the independence of the metric phenomena plays the chief part in the application of the theory of mean value. This independence is the essential requisite, and it is the very thing whose unwarranted assumption vitiates much biologic research.

An illustration may be drawn from fire insurance. From the records of past conflagrations of single houses, if the burning of each one is independent of that of every other, the theory of mean value can get a number which can be counted upon to recur with slight variation from year to year, and upon it can be based the charges for insurance.

To realize how completely this essential requirement may be lacking, we have only to remember the Chicago fire, or the Baltimore fire.

Biologists have treated their combinations as if they were simple summations of independent elements.

More likely are the combinations composed of interdependent factors whose symbolization must be at the simplest a product.

A tremendous illustration of variation under change of stimuli is given by Japan. For centuries environment and potential variability were in static balance; variation was zero.

Then came Commodore Perry, humiliations to the inordinate pride of a hermit nation, defeats, contempt, a tremendous response to the changes in stimuli, and today dark pagan Japan is easily defeating the largest European Christian white nation: variability unchanged, variation the greatest recorded in human history.

According to Quetelet's celebrated law of variability published some years after Darwin's Origin of Species, it is subject to the law of probability, and according to this law the occurrence of variations, their frequency and their degree of variation can be calculated and predicted in the same way as the chance of death, of murders, of fires.

But such applications did not fit actual evolution, since the law is to deal with different degrees of the same qualities, giving a continuity production of species, while as De Vries has so stressed, the origin may be by abrupt jumps, by sports, by mutations.

De Vries has said that a thorough study of Quetelet's law would no doubt at once have revealed the weak point in Darwin's conception of the process of evolution. It would have shown that the phenomena which are ruled by this law and which are bound to such narrow limits, cannot be a basis for the explanation of the origin of species.

It rules the degrees and amounts of qualities, but not the qualities themselves.

Species, however, as De Vries says, are not in the main distinguished from their allies by quantities, nor by degrees; the very qualities differ.

How such differences of qualitative character have been created is the burning question. They have not been explained by continuous accretion of individual variations.

The attitude of the new mathematics strongly favors attempts like the mutation theory, based on the abrupt, explosive changes, wholly discrete, which under the name of "sports" had long been observed and known in horticulture and animal breeding, and of which DeVries has found a whole fusillade being shot off by "Lamarck's evening primrose."

Here he says there is no gradual, no continuous change or modification, nor even a common change of all the individuals. On the contrary, he says, the main group remains wholly unaffected by the production of new species. After eighteen years it is absolutely the same as at the beginning. It is not changed in the slightest degree. Yet it produces in the same locality, and at the same time, from the same group of plants, a number of new species diverging in different ways.

The vastly vaunted natural selection, then, can only destroy new species, never create them.

The Relative Value and Extent of Scientific and Literary Teaching in a High School Course

J. C. HAMBLETON

In the preparation of a course of study for our High Schools it is necessary to bear in mind that there are two classes of pupils to be served, those who expect to continue their studies in some university and those who will not, at most, more than finish the High School course. Of these two classes the latter is far the more numerous and consequently the more important and should receive the greater attention. Usually they are the children of the middle classes and have parents whose opposition has had to be overcome before they are permitted to complete the High School course. It is for this class it seems to me we should endeavor to build a course of study, such that it will best fit them for the life that they will, by force of circumstances, be obliged to lead.

High school pupils are not all alike any more than are their parents. The child very early manifests the likes and dislikes that are to control its actions during life, and wise is the teacher or parent who is able to discover these tendencies and develop rather than attempt to destroy them. This then is ample reason for having a varied course of study wherever this is possible. Then, also the pursuits of men today are exceedingly varied, and to follow them successfully makes necessary many different kinds of preparation. Our colleges and universities have already learned this and now we see that almost every human occupation that requires knowledge and skill in its pursuit is taught in our institutions of higher education.

But the question is, shall this same latitude in the choice of studies be allowed in our high schools? Is it true, as some contend, that nothing but a few years of literary training will give a person that culture which is so essential to the true gentleman? Or, can he study the sciences and acquire that same mental ability that the study of the classics is reputed to give him? Will the time ever come when the study of Physics or Chemistry or Botany will occupy as prominent a place in our curricula as that which is occupied by Latin today?

We are all, of course, familiar with the early educational movement in Europe. That was an age when the mind of man was just awakening from a long slumber, aroused by the beauties of the literatures of old Greece and Rome. Soon after, the wave of religious enthusiasm in the form of the Reformation, that swept over Europe, gave to men an intense desire to study deeper into the mysteries of God's word. As a result of this awakening the study of Language and Literature grew in popularity and men thought that nothing more was required for a complete education. And were they not right? Would anything else have awakened men from the stupor of the Dark Ages?

Civilization, as we understand the term today, was then in its infancy. Simplicity marked all the pursuits of life. Machinery, all but the simplest types, was unknown. Streams were forded instead of being spanned by bridges. The great Ocean was a mystery upon which they dared not venture. But as time went on changes came. The science of Aristotle no longer satisfied the demand. Something larger, something truer, more real must come or men would again sink into that Chinese stagnation that had characterized their thought for so many hundreds of years.

The story is too well known to be related here. The demands of the world today are not what they were a thousand years ago, nay, nor a hundred years ago. Then will the education that they gave their youth a thousand years ago or a hundred years ago be the one that is best suited to prepare *our* youth for the complex struggle that is to meet them in a few years?

It seems to me that no sane man will say that our educational system is so perfect that it should be stereotyped for all time. Let us then leave these petty bickerings as to the greater value of this study than that, and recognize the one great general principle that when an organ is properly exercised its power is increased.

The progress of the world during the last half century has been phenomenal in many ways. Along what lines has this progress been most marked? Has it been along the line of literary production? Has the world been made broader or has it become a more comfortable or pleasant place to live in because of its literary productions? Can we truthfully say that the literature of the present day is very far in advance of that of the Elizabethan Age several hundred years ago? Then can we ascribe this wonderful advance in the world's progress to its influence?

Is the railroad, the factory, the coal mine, the telegraph and the thousand and one other things that make life livable at the present time due to the classical education that is dealt out by our institutions of Higher Education? Surely he must be a prejudiced partisan who will dare to answer this question in the affirmative.

Unquestionably, my friends, the scientific side of life has the upper hand at the present time. The greatest advancement in modern times has been along all lines of science and no one can doubt that this will continue for many generations to come.

Our secondary schools are and, of course, should be conservative institutions, but they like everything else must bow to the inevitable. They cannot maintain a course that is not in harmony with modern development. It is difficult to make an engineer believe that his success is due to the classical education that he may have had in his youth, and it will be still harder to make him see how his son's prospects in life will be spoiled by pursuing the sciences in the high school rather than Latin.

A new doctrine of philosophy put forth today, however plausible it may be, does not cause more than a ripple on the surface. The world reads about it, gives it a moment's thought and then forgets it. It is not so with the fate of some new invention or discovery. Surely no philosopher or literary man of modern times has stirred the world of thought as has Marconi. Nothing but theories in former times could furnish wings to the imagination, while today man finds outlet in things that are real, in things that will benefit the human race in a material way.

This is a materialistic age, however much we may regret the fact, yet fact it remains. The whole tendency of modern times is in this direction. Man is no longer punished for what he *thinks*. Little does it matter to me what my neighbor's theories and beliefs are, provided his *acts* are right and he allows me to live in peaceable possession of what I call my own. The modern institution of learning, be it Higher or Secondary, must recognize these facts and govern itself accordingly.

If we but pick up the text books of science of twenty years ago we shall see that the science work that was done at that time by our colleges is now being better done by our high schools. Is this true of other things? Did not our youth who were intended for the university in former times begin the study of Latin at the age of seven or eight years? Does anyone advocate this idea at the present time?

Then is it not plain that this scientific idea has already influenced and is still influencing our schools? And who will dare to say where the end may be? No, my friends, hard as it may seem to some of us, our schools must and will reflect, and be in harmony with the modern tendency, and all the argument and eloquence of a Demosthenes or a Gladstone can not prevent it.

While we all may recognize these facts, none can but acknowledge that the so-called scientific teaching in our high schools is in a chaotic condition. In fact, I think the principal objections to the science work is due to the fact that very often the classes are in charge of some one who has not been trained to do the work properly. How often do we find such classes thrust upon some one who has no natural aptitude or liking for the work, because there is no one else to take them. Not less frequently are such classes brought into ill repute because the teacher who has charge of them is not given the facilities that the proper pursiut of the study requires. Too often is it the case that the teacher of some branch of scinece in which laboratory work is essential, and without which it is but a memory exercise, is called upon to do as many hours actual teaching in the class room as the teacher of Latin or Mathematics, and then if he fail to obtain the results that are expected of him, either he or the study has to bear the blame when neither is at fault.

Then again the proper pursuit of such studies as Botany, Chemistry and Physics requires a more or less expensive outfit, which school authorities are often loth to give. But they too are advancing with the times and we now see the high schools in many small towns and even villages equipped with more adequate chemical and physical apparatus than that possessed by our largest high schools of fifteen or twenty years ago.

The march of progress is irresistible and the tendency of the times is unmistakable. The rapidity of its advance will be measured by the ability of our science teachers to bring order out of chaos. We must decide upon what is the best course for our high schools and then work for its universal adoption. Again we must not forget that the course of study does not make the school. Perhaps in no other department is the teacher so large a factor. Our universities should at all times be on the look-out for men and women who seem to have peculiar fitness for teaching these studies and encourage them to take up high school work. Pure scholarship and wide learning, while desirable, are not the most essential qualities of a good high school teacher. Take for instance, the teacher of Botany, He can find no text book to put into the hands of his class to which he can adhere closely. He must go to Nature for his text book, and have the ability to select such types for study as will give his pupils a lasting knowledge of the vegetable kingdom. He should be so well acquainted with the local flora that he can give his pupils an intelligent answer in regard to any specimen they may bring to him. He need not be a specialist on Mosses nor Fungi, but he should be able to tell one of these from the other and point out to his pupils the essential differences between them. He should not be satisfied to give up his class until his pupils are acquainted in a general way with the whole vegetable kingdom and can look with intelligent eyes upon the thousands of plants that surround them, from the lowest to the highest, and are acquainted with the great facts that underlie the science of vegetable physiology.

Zoology is another study that is destined to occupy the attention of our educators in the future to a much greater extent than it has in the past. However, once that the foundation principles of plant life have been well grounded much less time need be spent on this study than on Botany, in order to give the class as good an understanding of the animal kingdom as they have of the vegetable.

Nowhere in the whole course of study can such an opportunity be found to emphasize the importance of scientific classification as in the two branches just mentioned. Every successful man has his business systematized, and system means nothing but scientific classification. It seems to me that the teacher who does not bring out this principle misses the greatest opportunity that is offered to him.

Need anything be said of Mathematics and Physics? The former, by unanimous consent has long occupied a most prominent place in every course of study, and in recent years the latter has also taken its proper place as is made manifest by the fact that all high school teachers are now required to pass an examination in it before they are given a certificate to teach. This as you are aware only became law at the last session of the Ohio legislature.

Perhaps greater difficulty will be encountered in the systematic introduction of Chemistry into our high schools than in that of any other branch of science. This arises because of two conditions: first the expensive apparatus required, and second, the amount of time necessary for laboratory work, without which Chemistry is of little value. In no other branch of science teaching is there so little system and harmony. Even our colleges and universities can not agree upon what they want for admission. Some require a year's work with plenty of laboratory work, while others require none at all. Still others will accept a year's work, counting it as a science credit, for entrance, yet give no credit for it once the pupil is admitted. So long as this state of affairs exists in the college, little but chaos can be expected of the high schools.

As yet, the teachers of Chemistry in our high schools are not agreed as to the nature of the work that they should give their pupils. Some think a thorough grounding in the foundation principles of the science should be insisted upon, with a well selected list of laboratory exercises to illustrate them, while others wish to make more of a point of analytical work with laboratory work to suit. Still others, and these are by far the greater number. are obliged by force of circumstances to give their classes but a smattering of general principles with, perhaps, a poorly selected list of laboratory exercises, or none.

Whatever the solution to all these difficulites may be in time, there is one reform that must come about before this science can become firmly established. Nowhere is there enough attention paid to the industrial side of Chemistry. Our best text books have little to say about the subject and as a result the pupils finish the course without getting any adequate idea of what an important factor Chemistry is in modern life.

In my opinion the high school Chemistry, just as every other science, should not be too technical but should be developed along lines that come in contact with every day human experience. This would give those who will not pursue the study further a lasting knowledge of it and at the same time furnish a good foundation for more advanced study. But as I said before, some agreement must be arrived at by the colleges and then the high schools can have a basis upon which to work out a uniform system. Then and then only will Chemistry take the place it deserves in our high school course.

But ladies and gentlemen, I would not have you think for a moment that I wish to detract one iota from the importance of literary work. Great lessons can be drawn from the intelligent study of History that will be invaluable and indeed essential to the education of those into whose hands must fall the reins of government in the years that are to come. And of Language it is unnecessary for me to speak, especially of the mother tongue. Too much importance can not be attached to it, especially when we see so large a percentage of our high school graduates that can not write a correct business letter. One is almost inclined to think at times that we should again go back to the old spelling book.

Unquestionably, at least, one foreign language should be studied, and that thoroughly, and in my humble opinion, that language should be a modern one. But let this be left to the choice of the pupil or his parents.

I hope I have made myself plain; the scientists do not want everything. They only ask for a proper recognition of what they consider equal in importance to the literary work. They ask and have a right to demand that the science work be placed on a par with that of any other department, and that the pupils who select this course may not be made to feel that they are doing inferior work.

Ohio State Academy of Science Publications

First Report, and First and Second Annual Reports, **Price 25c each**

Third and Fourth Annual Reports.................. **Price 20c each**

Fifth to Thirteenth Annual Reports.................. **Price 15c each**

Special Papers—No. 1. "Sandusky Flora." pp. 167.
By E. L. MOSELEY........................... **Price 35c**

Special Papers—No. 2. "The Odonata of Ohio." pp. 116.
By DAVID S. KELLICOTT........................... **Price 35c**

Special Papers—No. 3. "The Preglacial Drainage of Ohio.
pp. 75. By W. G. TIGHT, J. A. BOWNOCKER,
J. H. TODD, and GERARD FOWKE.... **Price 35c**

Special Papers—No. 4. "The Fishes of Ohio." pp. 105.
By RAYMOND C. OSBURN........................... **Price 35c**

Special Papers—No. 5. "Tabanidae of Ohio." pp 63.
By JAMES S. HINE........................... **Price 35c**

Special Papers—No. 6. "The Birds of Ohio." pp. 241.
By LYNDS JONES........................... **Price 50c**

Special Papers—No. 7. "Ecological Study of Big Spring Prairie." pp. 96. By THOMAS A. BONSER .... **Price 35c**

Special Papers—No. 8. "The Coccidae of Ohio, I."
pp. 66. By JAMES G. SANDERS........................... **Price 35c**

Special Papers—No. 9. "Batrachians and Reptiles of Ohio." pp. 54. By MAX MORSE........................... **Price 35c**

Special Papers—No. 10. "Ecological Study of Brush Lake." pp. 20. By JOHN H. SCHAFFNER, OTTO E. JENNINGS, and FREDRICK J. TYLER. .... **Price 35c**

These publications will be sent to any address postpaid, on receipt of price.

Official Organ of the Academy, THE OHIO NATURALIST.

Address, W. C. MILLS, -- -- Librarian

OHIO STATE ACADEMY OF SCIENCE

Page Hall, Ohio State University, COLUMBUS, OHIO

PROCEEDINGS

Of the

Ohio State Academy of Science

VOLUME IV, PART 7

Fourteenth Annual Report

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume IV. Part 7

Fourteenth Annual Report

OF THE

OHIO STATE ACADEMY OF SCIENCE

1905

ORGANIZED 1891 INCORPORATED 1892

PUBLICATION COMMITTEE

J. H. SCHAFFNER JAS. S. HINE E. L. RICE

DATE OF PUBLICATION, OCTOBER 1, 1906

PUBLISHED BY THE ACADEMY
COLUMBUS, OHIO

Officers - 1906

PRESIDENT.

EDWARD L. RICE.

VICE-PRESIDENTS.

CHARLES DURY, LYNDS JONES,

SECRETARY,

L. B. WALTON,

TREASURER.

JAS. S. HINE.

LIBRARIAN.

W. C. MILLS.

EXECUTIVE COMMITTEE.

Ex-Officio.

EDWARD L. RICE, JAS. S. HINE, L. B. WALTON.

Elective.

M. F. GUYER, L. G. WESTGATE.

BOARD OF TRUSTEES.

W. R. LAZENBY, Chairman, term expires........................ 1906
C. J. HERRICK, term expires.................................. 1907
G. B. HALSTED, term expires.................................. 1908

PUBLICATION COMMITTEE.

JAS. S. HINE, term expires................................... 1906
E. L. RICE, term expires..................................... 1907
J. H. SCHAFFNER, Chairman, term expires...................... 1908

Past Officers

PRESIDENTS

1892.	E. W. Claypole,	1899.	G. F. Wright.
1893.	Edward Orton,	1900.	Josua Lindahl,
1894.	F. M. Webster,	1901.	A. D. Selby,
1895.	D. S. Kellicott,	1902.	W. R. Lazenby,
1896.	A. A. Wright,	1903.	C. J. Herrick,
1897.	W. A. Kellerman,	1904.	E. L. Moseley,
1898.	W. G. Tight,	1905.	Herbert Osborn,

VICE-PRESIDENTS.

1892. A. A. Wright, Ellen E. Smith.
1893. D. S. Kellicott, D. L. James.
1894. G. H. Colton, Mrs. W. A. Kellerman.
1905. H. E. Chapin, Jane F. Winn.
1896. A. L. Treadwell, Charles Dury.
1897. C. E. Slocum, J. B. Wright.
1898. Josua Lindahl, J. H. Todd.
1899. Chas. E. Albright, A. D. Selby.
1900. J. A. Bownocker, Lynds Jones.
1901. H. Herzer, Mrs. W. A. Kellerman.
1902. C. J. Herrick, C. S. Prosser.
1903. J. A. Bownocker, Miss L. C. Riddle.
1904. Lynds Jones, L. H. McFadden.
1905. C. W. Dabney, F. M. Comstock.

TREASURERS.

1892-95.	A. D. Selby,	1899-04.	Herbert Osborn,
1896-98.	D. S. Kellicott,	1905.	Jas. S. Hine.

SECRETARIES.

1892.	W. R. Lazenby,	1895-03.	E. L. Moseley,
1893-94.	W. G. Tight,	1904.	F. L. Landacre,

1905. L. B. Walton.

TRUSTEES.

1892-01.	F. M. Webster,	1900-05.	J. H. Schaffner,
1900 02.	H. C. Beardslee,	1901-05.	W. R. Lazenby,
1904-06.	C. J. Herrick,	1905.	G. B. Halsted.

PUBLICATION COMMITTEE.

1892.	F. M. Webster,	1900-05.	J. H. Schaffner,
1892-97.	W. A. Kellerman,	1901-03.	L. H. McFadden,
1892-96.	E. W. Claypole,	1902-04.	Gerard Fowke,
1897-99	E. L. Moseley,	1904-05.	Jas. S. Hine,
1898-00.	S. Belle Craver,	1905.	E. L. Rice

Membership

MAY 1, 1906

Life Member

McMillin, Emerson E............320 Riverside Drive, New York, N. Y.

Active Members

Aiken, W. H..................................Station K, Cincinnati
Albright, Charles E..............................Columbus
Armstrong, C. A., *Geolgy*................................Canton
Ball, E. D., *Entomology*............................Logan, Utah
Ballard, C. McE., *Biology*..............................Gambier
Baird, R. L., *Zoology, Geology*..........................Oberlin
Barnard, B. C................................Beaver Falls, Pa.
Benedict, S. M., *Physiology*.............Univ. of Cincinnati, Cincinnati
Berger, E. W., *Zoology*............................Lake City, Fla.
Bing, S. H., *Botany, Zoology*............................Bidwell
Black, J. G..Wooster
Bonser, T. A., *Botany, Geology*........02217 Monore St., Spokane, Wash.
Bownocker, John A., *Geology*.......................O. S. U., Columbus
Braam, Maximilian, *Biology*.................3114 Vine St., Cincinnati
Breese, B. B., *Psychology*...............Univ. of Cincinnati, Cincinnati
Brockett, Ruth E., *Botany*............................Rio Grande
Brookover, Chas............................Buchtel College Akron
Brugger, Harvey, *Botany*..................................Fremont
Bubna, Matthias, *Entomology*...................8 Heina St., Cleveland
Burgess, A. F., *Entomology*...Dept. of Agriculture, State House, Columbus
Carney, Frank, *Geology*................................Granville
Carter, Chas., *Entomology*..........State Normal School, Albion, Idaho
Claasen, Edo, *Botany*.............2537 Woodland Ave., S. E., Cleveland
Clark, W. B..Granville
Clevenger, J. F., *Botany*..............................Cedarville
Coberly, E. D., *Meteorology, Botany*.........Weather Bureau, Columbus
Cole, A. D., *Physics*..............................O. S. U., Columbus
Collett, S. W., *Botany*...................Univ. of Iowa, Iowa City, Iowa
Colton, George H...Hiram
Comstock, Frank M., *Vert. Zoology*.............Case School, Cleveland
Coover, A. B., *Archeology*.................1432 Hunter Ave., Columbus
Cotton, E. C., *Entomology*.......State Crop. Pest Com., Baton Rouge, La.
Copeland, W. F...Athens
Dabney, Chas. W......................Univ. of Cincinnati, Cincinnati
Davis, V. H., *Horticulture*..........................O. S. U., Columbus
Detmers, Freda, *Botany*......................1315 Neil Ave., Columbus
Ditto, T. W., *Botany, Entomology*......................R. D. 1, Delphos
Dunlap, Fred, *Forestry*..........U. S. Forest Service, Washington, D. C.
Durrant, E. P..Westerville
Dury, Chas............................537 Ridgway Ave., Cincinnati
Dutton, C. F., Jr............................64 W. Roy Ave., Cleveland
Edwards, E. H., *Zoology, Physiology* 7317 Clinton Ave. N. W., Cleveland
Feiel, Adolph...................................520 E. Main St., Columbus
Field, Irving A., *Biology*..............61 Oxford St., Cambridge, Mass.
Fischer, Walter, *Botany*....109 Maryland Ave. N. E., Washington D. C.

Fischbach, H. P., *Biology*........................Newport, Ky.
Flynn, Maud, *Zoology*.....................338 W. 6th Ave., Columbus
Fowke, Gerard, *Glacial Geology, Archaeology*..105 N. 2d St., St. Louis, Mo.
Frank, J. N., *Botany, Entomology*.................O. S. U., Columbus
Fullmer, E. L., *Botany*.................................Berea
Gary, L. B., *Geology*................................Austinburg
Gibbs, David ....Milan
Gregory, W. M.............................116 Olive St., Cleveland
Grover, F. O., *Botany*..................................Oberlin
Griggs, R. F., *Botany*...................1318 Forsythe Ave., Columbus
Guyer, M. F.........................Univ. of Cincinnati, Cincinnati
Halsted, G. B., *Mathematics*...............................Gambier
Hambleton, J. C., *Botany, Zoology*..........212 E. 11th Ave., Columbus
Hansen, Hermina J., *Biology*...........Hughes High School, Cincinnati
Hartzell, J. C.................Univ. of the Pacific. San Jose, California
Harvey, Ruth S., *Ornithology*.............................Bond Hill
Harvey, Gertrude F., *Ornithology*..........................Bond Hill
Hayes, Seth ....Lancaster
Heilman, Wm. T..............................Canal Winchester
Herms, W. B..Columbus
Herrick, C. Judson.....................................Granville
Herzer, H., *Paleontology*...............................Marietta
Hillig, Fred J............................St. John's College, Toledo
Hine, J. S., *Entomology, Ornithology*................O. S. U., Columbus
Hixson, A. H., *Zoology*......................................Ada
Hobbs, P. L., *Chemistry*..........Western Reserve Med. College, Cleveland
Hoke, Geo. W., *Geography, Biology*..........................Oxford
Holt, W. P., *Botany*....................1004 Jefferson Ave., Toledo
Houk, Eliza P. T., *Chemistry*..............................Dayton
Hubbard, G. D., *Geology, Physiography*..............O. S. U., Columbus
Hunt, Thomas F., *Agriculture*........................Ithaca, N. Y.
Hyde, J. E., *Geology*.....................................Lancaster
Jackson, C. F., *Zoology*..............................O. S. U., Columbus
James, C. B..................................Adelbert College, Cleveland
James, Davis L.........................127 W. Seventh St., Cincinnati
Janney, John J., *Horticulture*..............93 Fifteenth Ave., Columbus
Jennings, O. E., *Botany*.........Carnegie Museum Annex, Pittsburg, Pa.
Jones, F. T., *Physics, Chemistry, Mathematics*...35 Adelbert St., Cleveland
Jones, Lynds, *Ornithology*...................College Museum, Oberlin
Jones, Robt. Ralston, *Geology*........U. S. Engineer's Office, Cincinnati
Judson, C. A., *Botany*....................235 Columbus Ave., Sandusky
Keeler, Miss H. L., *Botany*......................93 Olive St., Cleveland
Kellerman, William A., *Botany*........175 W. Eleventh Ave., Columbus
Kellerman, Mrs. W. A., *Botany*........175 W. Eleventh Ave., Columbus
Kiefer, R. J.......................................Upper Sandusky
Koch, H. E., *Zoology, Physics*........Park and McMillan Sts., Cincinnati
Landacre, F. L., *Zoology*..............................O. S. U. Columbus
Lazenby, Wm. R., *Horticulture, Botany*..............O. S. U., Columbus
Lee, Mary E., *Geology*.................................Westerville
Lindahl, Josua, *Zoology*......................312 Broadway, Cincinnati
Lloyd, John Uri......................Court and Plum Sts., Cincinnati
Louth, E. V., *Botany*......................................Ashtabula
MacKinnon, J. A., *Ornithology*..............................
.......................care of Beecher, Peck & Lewis, Detroit, Mich.
Mally, C. W., *Entomology*......................................Texas
Martzoff, C. L., *Archeology*.........................New Lexington
Masterman, E. E., *Zoology, Botany*........................New London
Mathews, Mary E...Painesville

McCoy, C. T., *Botany*....................317 E. Mulberry St., Lancaster
McDaniel, J. E., *Biology*....................................Athens
McElhinney, Frank B., *Botany*........................New London
McFadden, L. H., *Chemistry*.............................Westerville
Mead, Chas. S., *Zoology, Botany*...............217 King Ave., Columbus
Mercer, W. F., *Biology* Ohio University, Athens
Metcalf, Zeno P...Plympton
Mills, W. C., *Archaeology, Biology*..................O. S. U., Columbus
Morse, Max W., *Zoology*..............600 W. 125th St., New York City
Moseley, E. L., *Zoology, Botany, Physiography*................Sandusky
Nelson, James A., *Zoology, Embryology*.................Ithaca, N. Y.
Newell, Wilmon, *Entomology*.........................Baton Rouge, La.
Oberholser, H. C...........1349 Harvard St. N. W., Washington, D. C.
Odenbach, F. L., *Meteorology*............St. Ignatius College, Cleveland
Osborn, Herbert, *Entomology, Zoology*..............O. S. U., Columbus
Osburn, Raymond C., *Zoology, Ichthiology*....510 W. 124th St., New York
Outhwaite, Joseph H., *U. S. Ordnance*.......................Columbus
Oviatt, H. L., *General Science*................................Norwalk
Pallister, H. D.......................1128 Independence St., Cleveland
Parrott, P. J., *Entomology*..............................Geneva, N. Y.
Peppel, S. V., *Chemistry*....................1538 N. High St., Columbus
Pickel, Geo. J., *Chemistry*...............St. Ignatius College, Cleveland
Piwonka, Thomas.......................243 Superior St., Cleveland
Prosser, C. S., *Geology*..........................O. S. U., Columbus
Pumphrey, J. Homer..Clayton
Rice, Edward L., *Zoology*....................................Delaware
Riddle, Lumina C., *Botany*........................O. S. U., Columbus
Roudebush, Lowell ....Owensville
Royer, John S., *Biology*....................247 N. 17th St., Columbus
Sandres, J. G., *Entomology, Botany*...........................
............Bureau of Entomology Dept. Agr., Washington, D. C.
Sanger, U. G., *Botany*.......................................Newark
Schaffner, J. H., *Botany*..........................O. S. U., Columbus
Seaton, Miss F.......................103 Glen Park Place, Cleveland
Selby, A. D., *Botany*.........................Experiment Sta., Wooster
Simkins, J. D., *Glacial Geology*...............................Newark
Slocum, Mrs. Belle...............................Wayne Bldg., Toledo
Slocum, C. E...Defiance
Smith, G. D., *Botany, Zoology*...................450 Spicer St., Akron
Smith, J. Warren, *Meteorology*.............Weather Bureau, Columbus
Snyder, F. D., *Zoology, Ethnology*..........................Ashtabula
Soule, William........................1804 S. Union Ave., Alliance
Stair, L. D.................................92 Wadena St., Cleveland
Stauffer, Clinton R., *Geology*................390 King Ave., Columbus
Sterki, Victor, *Conchology, Botany*..................New Philadelphia
Stickney, M. E., *Botany*....................................Granville
Stockberger, W. W., *Botany*........Dept. Agriculture, Washington, D. C.
Stoner, Minnie A., *Domestic Science*...............O. S. U., Columbus
Surface, F. M., *Zoology, Botany*..............................Eaton
Sutton, J. G., *Physics, Geology*...........................*Rushsylvania*
Sweezey, Ottto H..................1019 Olaho Lane, Honolulu, Hawaii
Taylor, Albert ....Bedford
Thompson, Mrs. King....................167 W. Tenth Ave., Columbus
Tillman, Miss Opal I., *Botany*....................O. S. U., Columbus
Tight, W. G. *Geology*..............................Albuquerque, N. M.
Todd, Joseph H., *Geology, Archaeology*........Christmas Knoll, Wooster
Todd, Otto K...Vermillion

True, H. L. . . . . McConnelsville
Tyler, F. J., *Botany* . . . . Bureau of Plant Industry, Washington, D. C.
Tyler, Harriet Burr, *Botany* . . Bureau of Plant Industry, Washington D. C.
Van Hook, J. M., *Plant Pathology* . . . . Experiment Station, Wooster
Waite, F. C. . . . . Western Reserve University, Cleveland
Walton, L. B., *Biology* . . . . Gambier
Webb, R. J., *Botany* . . . . Garrettsville
Webster, F. M., *Entomology* . . . U. S. Dept. Agriculture, Washington D. C.
Werthner, William, *Botany* . . . . Steele High School, Dayton
Westgate, Lewis G., *Geology* . . . . Delaware
Wetzstein, A., *Botany* . . . . 309 W. 141st St., New York, N. Y.
Whetsel, J. A. G., *Botany, Zoology* . . . . 193 Jefferson Ave., Brooklyn, N. Y.
Whitney, W. C., *Biology, Geology* . . . . Westerville
Wieman, Harry L., *Biology* . . . . Univ. of Cincinnati, Cincinnati
Williams, Stephen R., *Biology* . . . . Miami University, Oxford
Williamson, E. Bruce, *Ichthiology, Ornithology* . . . . Bluffton, Ind.
Wolfe, E. E., *Botany* . . . . Marietta College, Marietta
Wright, G. Frederick, *Geology* . . . . Oberlin
Yanney, Lula Hock . . . . Alliance
York, Harlan H., *Botany* . . . . Dept. of Botany, Columbia Univ., New York

Report of the Fifteenth Annual Meeting

of the

Ohio State Academy of Science

ANNUAL MEETING

The fifteenth annual meeting of the Academy was held in Cincinnati on November 30, December 1 and 2, 1905, the president of the society, Professor Herbert Osborn, presiding. On Thursday evening an informal meeting took place at the Museum of the Society of Natural History.

On Tuesday at 9:30 a. m. the meeting was called to order by the President in Room 27, Cunningham Hall, at the University of Cincinnati. The report of the Secretary was presented and accepted. Reference was made to the Field Meeting at Cedar Point. Sandusky, July 5-8th, in conjunction with the American Microscopical Society. This was attended by about 25 members of the Academy, and excursions were made to Johnson's Island, Kelly's Island, Put-in-Bay, and other places of interest.

The Executive Committee reported the following names elected to membership during the year:

MEMBERS ELECTED BY THE EXECUTIVE COMMITTEE NOV. 27, 1904, DEC. 1, 1905.

Ballard, C. E., Biology .... Gambier
Blackman, M. W., Zoology, Cytology .... Medical Department Western Reserve, Cleveland
Clevenger, J. F., Botany, Zoology .... Cedarville
Cotton, E. C., Entomology, Botany .... Ohio Dept. of Agr., Columbus
Coover, A. B., Archeology .... 1432 Hunter Ave., Columbus
Fischbach, H. P., Biology .... Newport, Kentucky
Hixson, A. H., Zoology .... Ada
Hoke, Geo. W., Geography, Biology .... Oxford
Hubbard, G. D., Geology, Physiography .... Columbus
Hyde, J. E., Geology .... Lancaster
Jackson, C. F., Zoology .... Columbus
Jones, F. T., Physics, Chemistry, Mathematics .. 35 Adelbert St., Cleveland
Jones, Robt. Ralston, Geology .... U. S. Engineer's Office, Cincinnati
Kock, H. E., Zoology, Physics .... Park and McMillan Sts., Cincinnati
Nelson, James, Zoology, Embryology .... Ithaca, N. Y.
Schultz, O. T., Protozoa .... Med. Dept. Western Reserve Univ., Cleveland
Smith, G. D., Botany, Zoology .... 450 Spicer St., Akron
Stauffer, C. R., Geology .... 390 King Ave., Columbus
Van Hook, J. M., Plant Pathology .... Experiment Sta., Wooster

The report of the Treasurer was presented and after reference to the Auditing Committee was accepted. The following is a brief summary:

REPORT OF THE TREASURER FOR THE YEAR 1905.

For the year since our last annual meeting the receipts, including balance from last year, have amounted to $246.14, and the expenditures to $245.67, leaving a cash balance of 47 cents.

RECEIPTS.

Balance from last year	$64 85	
Membership dues	158 00	
From sale of publications	23 29	
Total		$246 14

EXPENDITURES.

For printing the Annual Report	$98 56	
152 subscriptions to the Ohio Naturalist	76 00	
Miscellaneous	70 64	
Balance December 1, 1905	47	
Total		$246 14

Respectfully submitted,

JAMES S. HINE.

The report of the Librarian was read and adopted. It was moved and carried that the report be published.

LIBRARIAN'S REPORT.

Members of the Ohio Academy of Science:

I herewith take pleasure in presenting to the Academy my report upon the receipts from the sale of the publications of the Academy.

Amount on hand December 1, 1904	$0 13
Cash received for Annual Reports and Special Papers	21 43
Total cash	$21 56

REPORT OF EXPENDITURES FOR YEAR ENDING DEC. 1, 1905.

Paid for postage on letters and publications	$1 55	
Paid for express	62	
Paid for postage 13th Annual Report	6 74	
Paid for printing and paper	1 28	
		10 19
Cash paid treasurer, May 4, 1905	$5 40	
Cash paid treasurer, October 30, 1905	2 50	
Cash paid treasurer, November 1, 1905	1 20	
		9 10
		$19 29
Cash on hand December 1, 1905		$2 27
Total number of pub. sold during the year		$21 43
Total number of pub. sold last year		7 96
Increase		$13 47

I call the attention of the members to the fact that the early numbers of the Academy publications are about exhausted and advise those having an interest in science to avail themselves of the opportunity to secure a complete set of the publications for their library.

Our exchange list has also increased during the year and we now have the publication of twenty-six scientific societies and colleges available for reference by members of the Academy.

I urge upon the members the necessity of a correct mailing list and should they change their address to notify, at once, the Treasurer or Librarian.

Respectfully submitted,
WM. C. MILLS, Librarian.

REPORT OF THE BOARD OF TRUSTEES.

The appropriations made during 1905 were somewhat less than usual, it being deemed wise to reserve the balance for publication.

The Board of Trustees feel that excellent work has been done by the Academy, and realizes that not a little of this has been accomplished by the aid of the "McMillin research fund". If the work so well begun is continued it will not be long until the "Natural History of Ohio" is quite as complete and more up to date than that of any other.

RECEIPTS.

Balance on hand November 16, 1904	$114 89	
Check — Emerson McMillin — Nov. 29, 1904	250 00	
Total		$364 89

EXPENDITURES.

Special Paper No. 10	$30 00	
Herbert Osborn, expenses for travel in research work on "Insects"	22 00	
R. F. Griggs, expenses for travel in research work on "Willows"	20 92	
Cuts for paper on "Willows"	47 49	
Herbert Osborn, expenses for reasearch work on "Insects"	25 00	
		$148 41
Balance on hand November 20, 1905		$216 48

The Board has again received the annual contribution of Mr. Emerson McMillin of $250.00 to the research fund.

WM. R. LAZENBY, Chairman.
JOHN H. SCHAFFNER,

A Membership Committee, consisting of Mr. Dury, Dr. Guyer and the Secretary, was appointed by the President. They subsequently reported on the following names. These were duly elected.

MEMBERS ELECTED BY THE MEMBERSHIP COMMITTEE, DEC. 1-2, 1905.

BENEDICT, STANLEY M., Physiology........Univ. of Cincinnati, Cincinnati
BRAAM, MAXIMILIAN, Biology............Hughes High School, Cincinnati
BRANSON, E. B., Geology....................................Oberlin
BREESE, B. B., Psychology................Univ. of Cincinnati, Cincinnati
CARNEY, FRANK, Geology..................................Granville
HANSEN, HERMINE J., Biology..........Hughes High School, Cincinnati
MARTZOFF, C. L., Archaeology..........................New Lexington
McDANIEL, J. E., Biology....................................Athens
WIEMAN, HARRY, Biology................Univ. of Cincinnati, Cincinnati

Reading of papers commenced at 10:15 and continued until 12:05 p. m., when, after the appointment of a committee consisting of the Secretary, Prof. Landacre and Prof. Rice, to consider a revision of the Constitution and report at the next meeting, the Society adjourned to luncheon provided by the local committee.

At 1:15 p. m. the Society listened to the address of the President on "The Origin of the Wings of Insects." This was illustrated by an excellent series of lantern slides.

At 2:15 p. m. the reading of papers commenced and continued until 4:30 p. m. when a brief recess of ten minutes occurred. This was followed by Prof. Herrick's paper, "On the Present Status of Comparative Psychology."

At 5:30 p. m. the Society adjourned to partake of a dinner served by the University.

At 7:30 p. m. President Dabney of the University of Cincinnati, delivered an address entitled, "Our Modern Universities." This was followed by an informal reception in the parlors of the University.

On Saturday the meeting was called to order at 9:10 a. m. Attention was called to the death of two members during the year, Prof. A. A. Wright of Oberlin, and Rev. F. D. Kelsey of Toledo.

A resolution urging the necessity for a biological survey of the Panama Canal Zone before the cutting of the canal was unanimously adopted and the secretary was instructed to transmit the resolution to the proper authorities at Washington.

A committee, consisting of the retiring President, Prof. Herbert Osborn; the incoming President, Prof. E. L. Rice; and the Secretary, was appointed for the purpose of bringing the matter of a State Natural History Survey before the next session of the General Assemmly.

The Committee on Nomination of Officers, Prof. C. J. Herrick, Prof. W. C. Mills, and the Secretary, which had previously been elected by ballot, reported and the following were elected for the coming year:

President — Dr. E. L. Rice, Delaware, Ohio.

Vice-Presidents — Mr. Chas. Dury of Cincinnati, Ohio, and Professor Lynds Jones, of Oberlin, Ohio.

Secretary — Dr. L. B. Walton, Gambier, Ohio.

Treasurer — Professor J. S. Hine, Columbus, Ohio.

Librarian — Professor W. C. Mills, Columbus, Ohio.

Executive Committee (ex-officio) — Dr. E. L. Rice, Delaware; Dr. L. B. Walton, Gambier; Professor J. S. Hine, Columbus (elective) ; Dr. M. F. Guyer, Cincinnati; Dr. L. G. Westgate, Delaware.

Board of Trustees — Dr. G. B. Halsted (in place of retiring trustee).

Publication Committee — John H. Schaffner.

A committee was also appointed for the purpose of securing the co-operation of the libraries in the state to the end that scientific papers be rendered more available for members of the Society. This committee consisted of Prof. Mercer, Prof. Durrant, and Prof. Westgate.

Invitations to the Society to meet at Columbus in November, 1906, were read from President W. O. Thompson, and from the Secretary of the Biological Club of the State University. No definite action was taken, the matter being left to the Executive Committee.

After resolutions were passed expressing the appreciation of the Society for the courtesies extended by the people of Cincinnati, the faculty of the University of Cincinnati, and the officers of the Museum of Natural History, and, furthermore, thanking Mr. Emerson McMillin, of New York, for his continued interest in the welfare of the Academy, the Society adjourned.

The following is the complete program of the meeting.

Robert F. Griggs — "Report on the Willows of Ohio."

J. H. Todd — "The Relation of Medicine to Anthropology."

Henry F. Kock — "Observations on *Euglena viridis* and *Euglena sanguinea*."

E. W. Berger — "Habits of the Pseudoscorpionidæ principally (*Chelanops oblongus* Say)."

H. P. Fischbach — "Some Notes on a Myxobolus Occuring in a Diseased Fish (*Abramis chrysoleucas*)."

H. J. Hillig — "A New Case of Mutation (*Commelina nudiflora*)."

F. Carney — "The Geology of Perry Township, Licking Co.," illustrated by lantern slides.

Charles Dury — "How to Collect and Breed Xenos."

L. B. Walton — "A New Species of Japyx (*J. macgillvrayi*) with some Notes on the Morphology of the Hexapoda and Chilopoda."

J. S. Hine — "Notes on some Ohio Mammals."

W. A. Kellerman — "Corn Rust Cultures."

W. F. Mercer — "The Relation of the Motor Nerve-Endings to the Voluntary Muscle in Amphibia."

J. H. Schaffner — "The Reduction of the Chromosomes in Microsporocytes."

A. D. Cole — "Optical Experiments with Electric Radiation."

M. F. Guyer — "Guinea-chicken Hybrids."

L. G. Westgate — "Glacial Erosion in the Finger Lakes Region, New York.

L. B. Walton — "The Naididæ of Cedar Point, Ohio."

Harris Hancock — "The Present State in the Development of the Elliptic Functions."

W. C. Mills — "Mammalia of the Baum Village Site."

W. R. Lazenby — "Foreign Trees Naturalized in Ohio."

E. W. BERGER — "Notes on the Fall Webworm (*Hyphantria cunea*) in Ohio."

J. S. HINE — "Life-History Notes on Three Species of Mosquitoes."

A. M. MILLER — "Recent Classification and Mapping of Lower Ordovician in Kentucky." Illustrated by lantern slides.

S. R. WILLIAMS — "The Anatomy of *Boophilus annulatus* Say."

C. J. HERRICK — "On the Present Status of Comparative Psychology."

W. A. KELLERMAN — "A Botanical Trip Through Gautemala." Illustrated with lantern slides.

HERBERT OSBORN — "Further Report on the Hemiptera of Ohio."

J. M. VANHOOK — "*Ascochyta pisi*, a Fungus Disease of Seed Peas."

LYNDS JONES — "Additions to the Birds of Ohio."

W. A. KELLERMAN — "Exhibition of Selected Gautemalan Plants."

J. H. TODD — "The Garden of the Titans — Its Geology."

CHAS. BROOKOVER — "The Prosencephalon of *Amia calva*."

E. L. MOSELEY — "The Cause of Trembles in Cattle, Sheep and Horses, and of Milk-sickness in Man."

G. D. HUBBARD — "Physiography and Geography."

W. C. MILLS — "Description of a Teepe Site, Baum Village Site."

C. E. BALLARD — "A New Gregarine from the Grasshopper (*Melonoplus atlanis*)."

W. R. LAZENBY — "Habits of Introduced Weeds."

G. B. HALSTED — "An Application of Non-Euclidean Geometry."

W. F. MERCER — "Development of the Respiratory System in Amphibians."

GERARD FOWKE — 'Superficial Geology between St. Louis and Cairo."

W. C. MILLS — "Human Jaws as Ornaments."

L. B. WALTON — "Some Laboratory Methods."

W. R. LAZENBY — "Notes on the Germination of Seeds."

F. CARNEY — "Glacial Studies in the Vicinity of Newark."

A. F. BURGESS — "A Preliminary Report on the Mosquitoes of Ohio."

W. A. KELLERMAN, H. H. YORK and H. A. GLEASON — "Annual Report of the State Herbarium."

LYNDS JONES — "A Contribution to the Life History of the Common Tern (*Sterna hirundo*)."

F. O. GROVER — "Notes on Some Ohio Spermatophytes."

W. B. HERMES — "Studies on Insects that Act as Scavengers of the Organic Beach Debris."

ALBERT WETZSTEIN — "A List of the Plants of Auglaize Co., O."

R. E. BROCKETT — "Some Plants on the Campus and in the Vicinity of Rio Grande College."

LUMINA C. RIDDLE — "Bembicidæ of Ohio and Notes on Life History of *Microbembex monodonta* Say, and *Bembex texana* Cress."

C. F. JACKSON — "A Key to the Families and Genera of Thrysanura with a Preliminary List of Ohio Species."

JAS. A. NELSON — "A Note on the Occurrence of Sex Organs in Aelosoma."

JOSHUA LINDAHL — "Barite in a New Form (Pisolitic) from a 1,400 Foot Boring for Oil at Saratoga, Texas."

VICTOR STERKI — "Preliminary List of Land and Fresh Water Mollusca of Ohio."

VICTOR STERKI — "A Suggestion with Respect to Local Fauna Lists."

VICTOR STERKI — "Some General Notes on the Land and Fresh-water Mollusca."

On December 28th an informal meeting of the Academy was held in connection with the Allied Educational Societies at Columbus, Prof. Herbert Osborn acting as chairman, and Prof. J. H.

Schaffner as secretary in the absence of the regular president and secretary. The following program was given.

Edward Orton, Jr. — "Report on the Economic Work of the Ohio Geological Survey."

Charles S. Prosser — "Status of Stratigraphical Work in Ohio."

C. E. Sherman — "Progress of the Topographical Survey of Ohio."

Miss S. S. Wilson — "Elementary Science in the High School."

E. P. Durrant — "Amount, Time, and Purpose in View, in High School Biology.

B. F. Thomas — "Lecture and Demonstration in Light and Color."

L. B. Walton, Secretary.

Gambier, O., February 14, 1906

PRESIDENT'S ADDRESS

SUGGESTIONS.

Preliminary to the address proper which will be of a scientific nature, I desire to call attention to a few matters of concern to the Academy, matters which seem to me to be of importance in connection with its further growth and usefulness, and to offer a few suggestions.

In the fifteen years of the Academy's existence it has accomplished many laudable undertakings and has been the means of stimulating and furthering investigations in a number of different lines. Among the most important of its functions is the means it has given for co-operation and acquaintanceship among scientific workers of the state. Numerous papers on geology and the natural history of the state which have appeared from time to time in its publications are the tangible results of the efforts of its members. The use of the McMillin Research Fund has been, perhaps one of the most important influences in its work in recent years, and the amount of scientific investigations and the number of creditable papers which have been published as a result of the encouragement derived from this fund is, it seems to me, a remarkable and creditable showing for the money used. Among the important contributions which may be found listed among the papers credited to this fund are, Studies of Preglacial Drainage in Ohio, The Fishes of Ohio, The Ecology of Big Spring Prairie, The Tabanidae of Ohio, An Annotated List of the Birds of Ohio, The Coccidae of Ohio, Reptiles and Batrachians of Ohio, and other studies are in an advanced stage of progress and reports of these will soon be forthcoming. When we consider that this has been the result of a contribution of $250 per annum through a series of eight years we may flatter ourselves and congratulate the donor as to the showing made. Another matter in which the Academy was influential was the establishment of the Topographical Survey which has been progressing steadily and which when completed will furnish a basis of knowledge for many other lines. Our proceedings and special papers form a creditable series and are yearly growing more valuable.

In taking note of various lines of organized science in the state it will be an easy matter to see what lines are being most thoroughly pushed and where the Academy may best exert its efforts. The State Geological Survey is ably conducted and receives such support from the state as to make steady progress in this important line of investigation.. The Studies of the Archeology and History of the State, supported by the state in the Archeological and Historical Society are constantly increasing in value and justifying the expenditure of state funds which are appropriated for the purpose. In the State Board of Health much work of a scientific character is being accomplished and while bearing directly upon the public health at the same time contributes important additions to general science. Still other agencies accomplish excellent results.

The scientific workers of the state are, I presume, all seriously hampered for the want of extensive library facilities and it seems that it would be desirable, if possible, to inaugurate some system of co-operation between the different scientific workers of the state and the libraries, especially the State Library, in order to better this condition. The librarians fortunately co-operate in publishing lists of periodicals which are available in each library so that for this particular feature we can hardly ask an improvement. The plan, however, might be extended to cover exchange and further purchase of scientific books of an expensive character or publications of societies which are from their nature available in but few libraries and which from the fact that they are seldom in demand could readily be used at different institutions or by different workers with very little danger or inconvenience. The State Library has a few important serial publications, but I understand that its policy with reference to scientific publications has been to leave them for the State University, a policy which I hope may be modified, especially with reference to certain sets of journals which are practically inaccessible to all scientific workers of Ohio. The librarian has very cordially received a suggestion regarding some co-operation, and I feel assured that any resolution passed by the Academy would receive his cordial attention.

The plan which strikes me as possible would be for the Society to appoint a committee of three, representing different institutions, which might take the matter in hand, determining how far it would be possible to publish lists of serial journals available in the libraries of different institutions, including the State Library; to receive from members of the Academy suggestions as to publications that are especially desirable in their lines of work and to present lists of such as would be recommended to the State Library with the request that so far as possible such sets should be completed or provided for in the State Library. The arrangements by which books may be obtained from the State Library are already so admirable that probably no change would be necessary to make such journals accessible to all established scientific workers of the state.

Another matter which seems to me to be of particular importance and which may properly claim the efforts of the Society is that of greater support for the investigations upon the natural history of the state. Information upon the plants and animals existing in the state is so evidently desirable that the arguments for it seem hardly necessary. It may be briefly mentioned, however, that aside from the scientific questions as to distribution, abundance, increase, decrease, and extinction of species in the state all of which should be investigated before further changes occur, there is a great need of investigation in connection with various interests. They would form a sound foundation for the more exact teaching of science in our schools, a branch which is becoming more and more of fundamental importance in education. They have a very direct and important bearing upon the public health. Their service to the medical profession, represented by the Board of Health would no doubt be fully appreciated. The aquatic resources of the state, especially the fisheries interests, dependent upon the aquatic life of various forms would be enormously helped by an exhaustive study of the aquatic life of the different rivers and lakes.

While the Academy can through its individual members contribute considerably to the desired end, in such investigation the progress must of necessity be slow and there would seem to be every reason why investigations in this line as in Geology and Archeology should be directly supported by assistance from the state. Natural History Surveys are in progress in a number of different states and their results have proved of the utmost importance both as aids in education and as a foundation for economic applications. If the suggestion meets your approval it would seem to me well worth while to appoint a committee to take this matter into consideration and to suggest legislation to provide for such a survey.

Another item which has occurred to me at different times is the representation of different branches of science in the Academy. The work during recent years has been very largely in the line of Geology and Natural History, a fact which is very easily accounted for on the basis of the local interest in these subjects, but it seems to me very desirable that the Academy have a strong representation in other branches as well and there are, I feel certain, many questions which lie in other fields of science which might be studied with advantage in connection with this organization. The chemical problems connected with our water supply, coals, soils, etc., have certainly local interest and reports upon such problems would be particularly welcome in our meetings. The only suggestion in this connection I would offer now would be that our members as individuals exert their influence with their associates and friends in other branches of science, urge them to take part in our proceedings and in any way possible encourage their affiliation with our Society. The valuable work done by the Cincinnati Society of Natural History is a good illustration of the usefulness of local societies. I wish we had such a society in each of the large cities of the state. But such societies come only from the self-sacrificing effort of some individual or group of individuals. They cannot be forced into activity at will.

The topic to which I wish to ask your attention and which I present as the annual address provided for at each annual meeting may be entitled:

THE ORIGIN OF THE WINGS OF INSECTS.

Insects were evidently the first of all animals to acquire the power of flight. Except, perhaps, the birds, they have remained to the present time the most successful aerial navigators and they present certainly the greatest variety of wing structure. They are the only creatures among the invertebrate groups that have succeeded in developing the power of independent flight.

From an economic point of view the wings of insects constitute a most important fact since it is by this means that they are rapidly distributed from point to point and their destructive effects greatly enhanced. To the systematist the wings are of the utmost importance since they furnish the basis of classification for all divisions of the class. They have been plastic structures easily molded by adaptation and changes both by elaboration and reduction are numerous.

It becomes, therefore, a matter of special interest to inquire into the structure of these organs and to trace, if possible, the mode of their origin.

While such a study may not add anything to the solution of the practical problem of aerial navigation for man it will certainly instruct us to learn what we can as to how a problem so difficult for man was solved by such apparently insignificant animals.

Insects began to fly, that is, insects were provided with wings and we assume that they could fly, away back in the paleozoic age probably millions of years before any such locomotion was possible to birds or even the more ancient flying reptiles.

The most ancient of the fossil remains referred to as a winged insect are the Protocimex Silurica of the Ordovician of Sweden and next is a primitive orthopteran species formerly thought to be closely related to cockroach and called Paleoblattina douvallia taken from the middle Silurian.* It may seem to those unfamiliar with the methods of biology that inference as to the character of these forms from fragmentary fossils is of doubtful value yet so firm is our conviction as to the certainty of the association of certain types of structure that we build up around these little fragments, depicting the structure of an insect wing, though separ-

* Dr. E. H. Sellards (Am. Jour. Sci. Vol. XVI. p. 324) states the doubt existing as to the accuracy of the reference of these fossils to insects. Later appearance of first winged insects does not, however, alter the sequence of habit and structure for which this paper argues.

ated by immense gaps in geological time, all of the mechanism of a tracheated flying arthropod.

That they were insects, that they had a tracheal respiration and that they were capable of flight must be accepted else we may as well call in question the whole mass of knowledge based on fossil remains and which we so confidently accept as indubitable history of the forms of life which peopled the earth in past ages.

So much for the antiquity of the organ which we have in discussion and we may perhaps give pause for a moment to think how long since and by what lowly creatures was the problem of aerial navigation solved, a problem so attractive yet so elusive to the powers of man. How then was the problem solved, what were the factors conspiring to provide for flight?

It is hardly necessary to remark that the wing of an insect is a totally different structure from the wing of a bird. The most superficial observation as well as the most elementary knowledge of anatomy is sufficient for this. Their minute structure and the process of their growth are, however, less familiar and in order to secure a firm foundation for the discussion of the mode of origin we must show something of this fundamental structure and its agreement in different kinds of insects — a bit of dry anatomy, a skeleton on which we may hang our threads of theory.

The insect wing is fundamentally a sack the membranous walls of which are supported by a series of stiff rodlike "nerves" or "veins". A sacklike structure is easily seen in the expanding wings of a moth or butterfly. As the rodlike supports fit to each other above and below the fluid not used in the formation of the wing is withdrawn into the body and the membrane hardens so no separation between the upper and lower layer is noticeable. So much may easily be accepted as common to all insects. Is there any similar uniformity with regard to the number and arrangement of the veins?

In the different orders of insects we have quite diverse apparent arrangement so that comparison of a mature cockroach, dragon fly, Cicada, house fly, beetle, butterfly and bee would show what appear to be very different patterns of veins. So different indeed that entomologists have applied very different sets of names to the various nerves and while various attempts have been made to establish uniform systems, such attempts have been largely unsuccessful. Quite recently through elaborate studies of Professors Comstock and Needham this uniformity has been much better established and we can say with very great assurance that the wing structure of all insects is reducible to a common plan or, to carry out the logical conclusion from this, that the wings of all insects are derived from one ancestral form.

I need not here burden you with the technical names of these structures or of the detailed statement of their homology. Reference to the beautiful figures and descriptions in the work of Comstock and Needham just mentioned will suffice.

Granting, however, a common origin for the wings of all insects the problem of their original appearance, the factors in development become all the more interesting. In order to show the position taken by different students of the subject I beg to quote a few paragraphs from various sources. Gegenbaur presents the following: "The wings must be regarded as homologous with the lamellar tracheal gills, for they do not only agree with them in origin, but also in their connection with the body and in structure. In being limited to the second and third thoracic segments they point to a reduction in the number of the tracheal gills. It is quite clear that we must suppose that the wings did not arise as such, but were developed from organs which had another function, such as the tracheal gills; I mean to say that such a supposition is necessary, for we cannot imagine that the wings functioned as such in the lower stages of their development, and that they could have been developed by having such a function."

This general view is stated a little more in detail by Lang: "The problem of the phylogenetic origin of the wings of insects is extremely difficult and as yet by no means solved. The rise of such organs is not explained by saying that they are integumental folds, which gradually increased in size, stood out from and eventually articulated with the body. The wings must in all stages of their phylogenetic development have performed definite functions. It is impossible that they were originally organs of flight. What function it was that they performed before they became exclusively organs of flight, is, however, entirely a matter of conjecture. The following view is at present the most acceptable. (1) The ancestors of the Hexapoda were, like the now living Apterygota, wingless land animals breathing through tracheae. (2) The Apterygota-like ancestors of the Pterygotan racial group became adapted to living in the water. Dorsal integumental folds served for breathing in the water. The rise of such respiratory folds offers no difficulty, since every increase of surface, small or large, is of service. (3) The respiratory appendages (into which the trachea were continued) became movable and may perhaps have assisted in locomotion (swimming). This assumption also offers no difficulty, since the gills of many aquatic animals are movable, and their power of moving is an advantage on account of the exchange of water thus caused. (4) In a new gradual change to land life the respiratory function became less important and the locomotory function came to the front. Here, however, lies the greatest difficulty. It may, however, be assumed that the animals, while still living in water were capable of gliding over the surface of the water by the swinging of their branchial leaves, just as flying fish do by means of their thoracic fins.

The limitation of the wings to the two pairs of meso — and metathorax must be explained mechanically as more suited for the propulsion of the body in flight. We still see among living insects an undoubted tendency to the stronger development of one of the pairs of wings.

Opposed to this view is McMurrich: "Granting a descent of the Pterygota from wingless ancestors, it becomes an interesting problem to discover the origin of the wings. Attempts have been made to show that they are modified tracheal branchiae, a theory which necessitates the derivation of the Pterygota from aquatic ancestors. Such a derivation, however, is unsupported by any evidence at present at our disposal, it being much more probable that the immediate ancestors of the Pterygota were terrestrial, just as Campodea is today. The wings arise in the embryo as dorsal outpouchings of the meso- and meta-thorax, tracheae later pushing out into them and transient indications of outpouchings of the prothorax also occur in some embryos. It has been suggested that primarily the wings were plate-like outgrowths on the thoracic segments which served to break the fall and increased the distance traversed by jumping insects, and in support of this view the fact may be mentioned that many Apterygota are saltatorial. The limitation of the wings to the meso- and meta-thorax may stand in some relation to the center of gravity of the body."

Aside from the lack of any indication of plate-like growths for respiration as here necessitated, it is only necessary to mention the fact so well known to all students of insect structure that the saltatorial Apterygota are a much specialized group, the saltatorial organ a bent-under appendage of the abdomen and never associated in living forms with any structure or habit leaning toward tracheal outgrowths to appreciate the difficulties of this suggestion.

A very full statement of this position was given by Dr. Packard in 1883 and since this was repeated quite fully in his recent text-book in 1898 it may be considered as the position held until his death.

"Now, speculating on the primary origin of the wings, we need not suppose that they originated in any aquatic form, but in some ancestral land insect related to existing cockroaches and Termes. We may imagine that the tergites (or notum) of the two hinder segments of the thorax grew out laterally in some leaping and running insect; that the expansion became of use in aiding to support the body in its longer leaps, somewhat as the lateral expansions of the body aid the flying squirrel or certain lizards in supporting the body during their leaps. By natural selection these structures would be transmitted in an improved condition until they became flexible, i. e., attached by a rude hinge joint to the tergal plates of the meso- and meta-thorax. Then by continued use and attempts at flight they would grow larger, until they would become permanent organs, though still rudimentary, as in many existing Orthoptera, such as certain Blattariae and Pezotettix. By this time a fold or hinge having been established, small chitinous pieces enclosed in membrane would appear, until we should have a hinge flexible enough to allow the wing to be folded on the back, and also to have a flapping motion. A stray tracheal twig would naturally press or grow into the base of the new structure. After the trachea running towards the base of the wing had begun to send off branches into the rudimentary structure, the number and direction of the future veins would become determined on simple mechanical principles. The rudimentary structures beating the air would need to be strengthened on the front or costal edge. Here, then, would be developed the larger number of main veins, two or three close together, and parallel. These would be the costal, subcostal and median veins. They would throw out branches to strengthen the costal edge, while the branches sent out to the outer and hinder edges of the wings might be less numerous and farther apart. The net-veined wings of Orthoptera and Pseudoneuroptera, as compared with the wings of Hymenoptera, show that the wings of net-veined insects were largely used for respiration as well as for flight, while in beetles and bees the leading function is flight, that of respiration being quite subordinate. The blood would then supply the parts, and thus respiration or aeration of the blood would be demanded. As soon as such expansions would be of even slight use to the insect as breathing organs, the question as to their permanency would be settled. Organs so useful both for flight and for aeration of the blood would be still further developed, until they would become permanent structures, genuine wings. They would thus be readily transmitted; and being of more use in adult life during the season of reproduction, they would be still further developed, and thus those insects which could fly best, i. e., which had the strongest wings, would be most successful in the struggle for existence. Thus also, not being so much needed in larval life before the reproductive organs are developed, they would not be transmitted except in a very rudimentary way, as perhaps a mass of internal indifferent cells (imaginal discs), to the larva, being rather destined to develop late in larval and in pupal life. Thus the development of the wings and of the generative organs would go hand in hand, and become organs of adult life."

That there are insuperable objections to this view will be evident if we weigh carefully the significance of the wing structure, especially its tracheation and musculature and we have absolutely no evidence in parallel structure or otherwise of such actual history.

On the other hand the chief difficulty in the theory of aquatic origin, the difficulty which for a long time seemed to me to invalidate this view, was in the absence of any primitive aquatic form, all aquatic groups showing most positive evidence of being so by secondary adaptation. The great majority of insects and practically all members of some orders have no aquatic stages nor do they show any trace of aquatic elements in their ancestry. Moreover, the most ancient fossil forms known have been distinctly terrestrial in character, nor do we have any trace of appearance of forms that can be referred to modern groups aquatic in character until considerably later in the geological record.

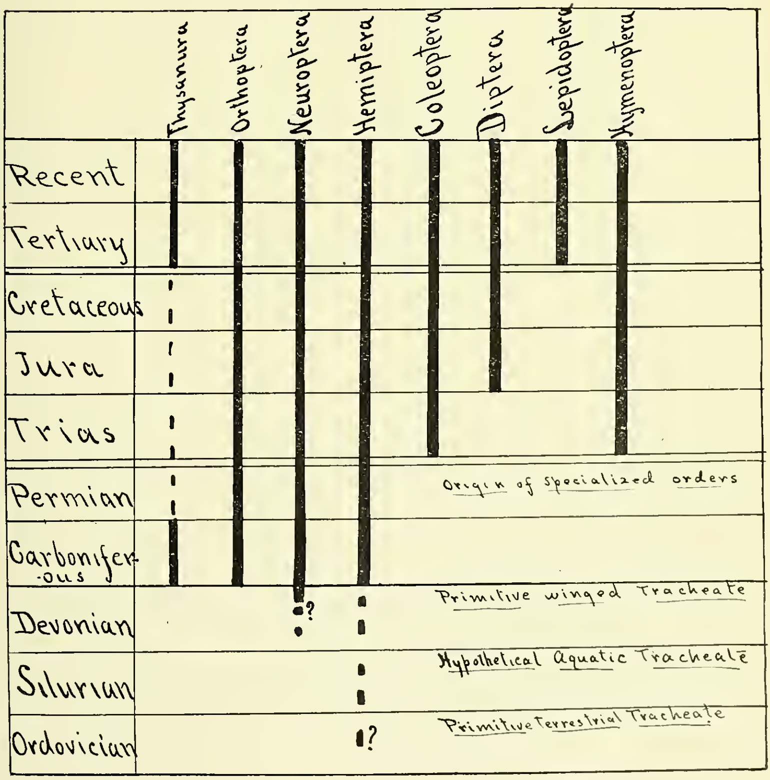
The generalized and very ancient orthoptera, for example, have nowhere aquatic stages or indication of any such habit. All the aquatic insects of the present time, moreover, have best of evidences of being primarily terrestrial, their aquatic habit an adaptation and in most cases the evidence of adaptation indicating fairly recent resort to that habit. Practically all aquatic forms retain tracheal respiration showing indisputable evidence of adaptation from aerial life, the few cases of blood gills — as in Simulidae — resulting evidently from extreme specialization in recent time.

It seems very difficult, however, to conceive of any condition outside of water which could furnish the basis for development of a tracheated membranous expansion from the body wall, the origin of such organs direct for the purposes of flight being excluded from consideration on the ground that no such organ could be of any functional service till sufficiently developed to serve some purpose in locomotion. Further the manner of articulation of wings to body, the fact that their movement is secured by movements of the body wall, not by direct muscular action, is excellent proof that they were first developed for some other function than flight. Moreover, such structures are paralleled by the tracheal gills of some modern aquatic forms.

We are forced then to the ground that the development of the tracheal membrane was in water, and we are shut out from considering any of the existing aquatic groups as furnishing a basis as the ancestral aquatic form.

We are left then with one other alternative and this on careful examination seems to offer a really satisfactory solution for the problem. That is, that back of the earliest fossil winged insect such as Protocimex, Paleoblattina, or the first of the Paleoblattidae there must have been an aquatic form which in its adaptation to aquatic life developed tracheal gills in the form of membranous tracheal expansions on the two hinder thoracic segments; that this hypothetical form changed its habitat to land and the membranous structures instead of being lost were modified into wings. Then from this primitive winged form we have by divergence the various groups of orders of modern insects established and in some of these by adaptation again to aquatic existence we have in many instances a well developed aquatic stage with many resulting respiratory structures — these in some instances resembling in some degree the primitive form but not occupying position previously pre-empted by wings.

The bearing of these conclusions on the early phylogeny of the group of insects is evident and we are practically forced to carry the origin of the group back more remotely in time to connect it as seems necessary with a primitive, wingless, tracheate ancestor. The elaboration of such a phylogeny in so far as the evidence may justify is beyond the scope of this address but its general bearing may be indicated in graphic form by adaptation of the diagram showing the distribution of different groups of insects in time. The diagram adapted from latest edition and translations of Zittel's Paleontology is of course poorly adapted to show the present views of direct affinity but will serve our purpose to indicate time of appearance of different orders.



STRATIGRAPHIC GEOLOGY.*

(By Charles S. Prosser.)

The science of Stratigraphic Geology was founded by William Smith, an English surveyor and civil engineer, who was born in 1769 in Oxfordshire, a county in which the rocks contain abundant fossils which as a boy he observed and collected. Later as an assistant to a land surveyor he became intimately acquainted with a considerable portion of southern England. For twenty-five years he continued his investigations in that country, making colored geological maps, determining the stratigraphy and arranging a collection of fossils in the chronological order of the succession of the strata. In the course of this long investigation he was able to trace certain strata across England, and he discovered that each horizon could be identified by its characteristic fossils. His famous geological map of England and Wales on which the various divisions were represented by different colors was published in 1815 and this was the first representation on a large scale of the geological formations of any considerable part of Europe. Accompanying the map was an explanatory text of some fifty pages in which the stratigraphic divisions received names adopted from local ones in use where the rocks had been studied. In 1816 he published what is usually considered his greatest work, entitled "Strata identified by organized fossils, containing prints of the most characteristic specimens in each stratum." Thus was stratigraphic geology founded through the unceasing efforts of an investigator of his own country who, for a long time without even the encouragement of other students of the subject still remained true to his ideal. In considering his rank among other pioneers of the science the eminent German geologist, von Zittel has written that "His greatness is based upon this wise restraint and the steady adherence to his definite purpose; to these qualities, the modest, self-sacrificing, and open-hearted student of nature owes his well-deserved reputation as the 'Father of English Geology'."[1]

In this connection it is specially important to note the prominence of the study of fossils in the organization and development of stratigraphic geology.

Apparently one of the first geological reports relating to any

---

* The following address on *Stratigraphic Geology* was prepared at the request of Professors Edward Orton, Jr., and Herbert Osborn and read at the meeting of the Ohio Academy of Science, December 28, 1905.

1 History of Geology and Palaeontology to the end of the Nineteenth Century. Ogilvie-Gordon translation, 1901, p. 112.

portion of the United States was written by Dr. Samuel L. Mitchill of New York concerning the rocks of that state and published in the Medical Repository in 1798 and 1799.[1] At the close of the eighteenth century scarcely half a dozen men in this country understood the elements of geology. One of these was Professor Benjamin Silliman, who graduated at Yale College in 1796, and in 1818 founded the American Journal of Science, which was the first distinctly scientific periodical published on this continent that has continued to the present time. An idea of the equipment for the study of this science in the leading scientific educational institutions of this country at the beginning of the nineteenth century may be gained from the statement that Professor Silliman carried the whole mineral collection "at Yale for examination and study to Philadelphia, in a candle box."[2]

Prominent among these early students of geology were William Maclure, who published the first geological map of the United States in 1809, and Amos Eaton, a graduate of Williams College, who later attended lectures in Yale College and in 1817 became a lecturer on chemistry, botany, mineralogy and geology in his *alma mater*. Eaton and Theodore R. Beck were selected by the wealthy Patroon the Hon. Stephen Van Rensselaer, in 1820, to conduct the first geological survey of any district in this country, viz: Albany county, New York. Two years later he was appointed to survey that portion of New York state adjacent to the Erie Canal, which was then in process of construction. The expense of this pioneer work was borne by Van Rensselaer, this country's first patron of the science. Eaton classified the rocks to a certain extent and to one of the divisions he gave the name of Corniferous limestone, a name that for many years has been well known in this state. Later Van Rensselaer made Eaton senior professor in Rensselaer school in the city of Troy, now known as the Rensselaer Polytechnic Institute, which became under his instruction for a time the most noted school in geology in this country.

To the west of Albany county lies the rugged one of Schoharie, crossed by the northern escarpment of the Helderberg plateau, or mountains, and deeply trenched by the Schoharie creek, a southern tributary of the Mohawk river. In the Schoharie valley near the village of that name lived the Gebhards, a prominent and well-to-do family of gentlemen farmers, father and son, who between 1820 and 1835 worked out the succession of Silurian and Devonian

1 The statement of Professor Chester Dewey is that "The Society for Promoting Agriculture, Arts and Manufactures," incorporated in 1793, afterwards merged in the Albany Institute, appointed Dr. Mitchill Commissioner to examine and report on the "Minerals of the State;" but his report treated chiefly of the rocks. (Tenth An. Rept. Regents of the University of the State of New York, 1857, p. 14, f. n.)

2 Ibid., p. 14

"strata in that remarkable section, collected their fossils and proposed their own stratigraphic terms,"[1] some of which as for example, Pentamerus limestone and Tentaculite limestone are still familiar names to geologists.

This work of Eaton and the Gebhards marked the beginning of stratigraphic geology in America which in eighty-five years has extended to every state and territory of this country and to every province of Canada.

It is claimed that North Carolina was the first state to order a geological survey. In 1824 Professor Olmstead was appointed State Geologist and in that year and the following one he published a report of one hundred odd pages. Her sister state of South Carolina followed in 1825 with the appointment of Professor Vanuxem; but as his results were not published by the state they were consequently lost, except what appeared in the periodicals. In 1830 Massachusetts ordered a trigonometrical and geological survey of the state with Professor Edward Hitchcock of Amherst College as State Geologist. The thirties were prolific years in the organization of state surveys and during this period such surveys were established by Maryland, Tennessee, Arkansas, New York, New Jersey, Pennsylvania, Virginia, Georgia, Maine, Connecticut, Ohio, Michigan, Delaware, Indiana, Kentucky, Missouri, the David Dale Owen Survey of Illinois, Iowa and Wisconsin, and in Canada by New Brunswick and Newfoundland.

The Geological and Natural History Survey of New York was not authorized until twelve years later than the first one of North Carolina. Still it must be conceded by any one conversant with the history of geology that none of the other surveys exerted so great an influence in the development of American geology; nay, I will go further and state that the combined influence of *all* the other states was not equal to that of New York. This may seem like a strong statement but permit me to read from an address by McGee delivered at the celebration in honor of the sixtieth anniversary of Professor James Hall's public service as a geologist of New York. Let us remember in passing that McGee is a native of Iowa, was never a resident of New York nor a member of its survey and was not a paleontologist. Among other things he said: "Other systems of nomenclature have come and gone; the brilliant and attractive * * * system proposed by the Rogers brothers for a time competed with the system devised in New York; but no other system has endured the test of time * * * The New York formations were defined by fossil contents, as were those of England and the Continent, while the nature and genesis of deposits were given greater weight than before; and this method has been followed more or less closely by the geologists of the world

1 Dr. John M. Clarke in High School Bul. 25, 1903, p. 497.

engaged in researches among the clastic rocks. Most of the New York formations were named from geographic features so chosen as to indicate type localities and to permit endless rearrangement of the duly labeled rock divisions as research progressed and other divisions were recognized; and this system of nomenclature which was practically original in the New York survey as applied to minor divisions in [the] geologic column, stopped not at the boundaries of the state, but has spread over the country and the world, and is today the accepted system of civilized lands."[1]

The New York survey was organized in July, 1836, and the state was divided into four districts with a Chief Geologist for each one; but with no one as State Geologist or chief in authority, save the Governor. The first year the geologists of the four districts were Lieut. William W. Mather of the First, Dr. Ebenezer Emmons of the Second, Timothy A. Conrad of the Third, and Lardner Vanuxem of the Fourth, while James Hall, a young man of twenty-four, who had been a student of Eaton in the Rensselaer School, graduating in 1832, was an assistant geologist of Dr. Emmons in the Second District. The following year the boundaries of the districts were changed considerably. Conrad became the Paleontologist, Vanuxem was transferred to the Third, and Hall placed in charge of the Fourth District. The law provided for the continuance of this survey for four years with an annual appropriation of $36,000 and at its expiration was continued for an additional two years. At the conclusion of this work a quarto volume was prepared by each geologist for his district, while Professor Hall remained to describe the fossils and continued as State Geologist or Paleontologist until his death in his eighty-seventh year in 1898. He has appropriately been termed the Nestor of American Geologists. The magnificent series of volumes devoted to the geology and paleontology of New York are known to every geologist throughout the world and have cost that state over a million and a half dollars. In New York there are three formations of bituminous shales with extended outcrop, which are lithologically similar to shales often found in association with coal, and on account of the early determination of the greater age of these shales than coal-bearing rocks it has been estimated that the amount of money saved from useless exploration fully equals the sum the state has expended for its Geological Survey. The work, however, is considered as far from finished and under Dr. John M. Clarke, the worthy successor of Professor Hall, the survey is energetically continued.

Now let us consider the history of geological work in Ohio, and in the time allowed me, this will of necessity be a very brief review. Perhaps the earliest papers relating to the geology of

1 Science, N. S., Vol. IV, Nov. 13, 1896, p. 702.

Ohio were two published by Caleb Atwater of Circleville in volume I. of the American Journal of Science, the first entitled "On the Prairies and Barrens of the West," and the second, "Notice of the Scenery, Geology, Mineralogy, Botany, etc., of Belmont County." The first state geological survey was created under the authority of an act passed by the Legislature in March, 1837, providing for "a complete and detailed geological survey of the State," which also included the construction of a geological map of the state and the collection of the fossils of the various formations. The Legislative Committee recommended an annual appropriation of $12,000 for four years, the appointment of "a skilled geologist," with not more than four assistants and in addition a topographical engineer. The Governor appointed as Principal Geologist, Lieut. Wm. W. Mather, at that time Geologist of the First District of New York; Drs. S. P. Hildreth and John Locke and Professors J. P. Kirkland and C. Briggs, Jr., as assistants, with Col. Charles Whittlesey as topographical engineer. The field work was begun late in 1837 but was actively prosecuted during the field season of 1838 and at the close of that year the survey had cost the state $16,000, when it was abruptly terminated. Two annual reports were published by Mather and his assistants, which were quite similar in plan to those of New York, Pennsylvania and Virginia, and a beginning was made toward a description of the geology of the state. How elementary most of this was, however, may be seen from the section of central Ohio in the second report in which the Devonian limestones on the Scioto at Columbus are given as "Mountain limestone," which belongs in the Subcarboniferous; while what is now known as the drift was referred to the Tertiary. Still the survey, brief as was its life, was of great value and Dr. Orton has made the statement that "The state never received larger returns from any other equal expenditure than from the $16,000 used" for its maintenance, and that the increase of wealth in a single county due to "the development of mining industries, largely based on the work of the survey, was * * * many times more than the entire expenditure which the state had made in its support."[1]

From the termination of the first survey at the close of 1838 until the passage of the bill in March, 1869, "providing for a Geological Survey of Ohio" the state did absolutely nothing toward furthering the knowledge of its geology and geological resources. This was a formative period in American geology in which nearly all the northern states and part of the southern had supported state surveys for a longer or shorter period and published fairly accurate reports. Even the first tier of states beyond the Missisipi had published quite elaborate reports of large octavo or quarto

1 Jour. Geol., Vol. II, 1894, p. 507.

size. The backwardness of Ohio had long been a source of humiliation to some of her more intelligent citizens and it is safe to say that at the beginning of 1869 less was known concerning the Natural History and Geology of Ohio than of any other northern state.

The Second Geological Survey of Ohio, as it is generally termed, was organized by Governor Hayes in 1869 with Dr. J. S. Newberry, chief Geologist; Professors E. B. Andrews, Edward Orton, and Mr. John H. Klippart, assistant geologists. In the list of local assistants that served on this survey are the names of men who afterward became famous geologists, as for example, R. D. Irving, Henry Newton, G. K. Gilbert, J. J. Stevenson and N. H. Winchell. Dr. Newberry was a native of Ohio and his interest in geology was first aroused by the visit of James Hall at his father's house in Cuyahoga Falls on Hall's famous geological trip to the Mississippi Valley in 1841 and "Newberry used to say that Hall came as an angel, but before he went away he had become almost divine."[1] At the time of Dr. Newberry's appointment he was professor of geology in the School of Mines of Columbia College, New York city, a position which he did not deem it expedient to resign. Newberry's plan for the survey was a wise one and the first really comprehensive one that had been formulated concerning a Geological and Natural History Survey of the state. His broad grasp of the problem may be seen from the following statement in his first Report of Progress:

"During the many years that had passed since the former board was disbanded, geological surveys had been maintained, with more or less thoroughness, in New York, Pennsylvania, Kentucky, Indiana, Illinois, Missouri, Arkansas, Kansas, Iowa, Wisconsin, Michigan and Canada, and the observations made by the geologists of those states in different and widely separated localities, had presented discrepancies that had given rise to long, earnest, and sometimes bitter discussions. Before the diverse conclusions of these various observers could be harmonized, and the succession and distribution of the rocks represented in our geology be fully made out, it was necessary that these views should be compared in Ohio; that observations made east, west, north and south should here be connected. Ohio thus, in some sort, formed the keystone in the geological arch reaching from the Alleghenies to the Mississippi; and for many years geologists in our own country and abroad had been looking forward with interest to the time when the geological survey in Ohio should supply this keystone, and render our whole geological system complete and symmetrical. It was also necessary that our work should be, first of all, blocked out in its generalities; that we should learn precisely what forma-

1 Professor J. J. Stevenson in Science, N. S., Vol., IV, p. 716.

tions were represented in the state, their order of superposition, their mineral character and contents, their thickness and the geographical areas occupied by their outcrops."[1]

I have said that the above plan is a comprehensive one and I believe it will be so conceded when it is once understood that all the details of it as enumerated in the last sentence of the above quotation are as necessary for the guidance of the Geological Survey today as when they were published thirty-five years ago. Furthermore, some idea of the magnitude of the work outlined may be gained when it is stated that probably not more than one-half of it has as yet been accomplished, in spite of the valuable and extensive contributions made by the Newberry Survey and that of his worthy successor, Dr. Orton. Time does not permit of an analysis of the results of these surveys; but suffice it to say that the Annual Reports of 1869 and 1870 and Volumes I, II and III of the Newberry Survey were devoted quite largely to stratigraphic geology and that some progress was made in describing the geology of eighty-five of the eighty-eight counties of the state. The county reports were in the main accompanied by a geological map on which some of the larger divisions were represented; but in very few instances was this areal work carried to a sufficient degree of refinement for the representation of units or formations. A list of the geological formations as at present recognized in this state has recently been published by the Geological Survey of Ohio.[2] Each survey also published a Geological Map of Ohio. Newberry's is on the larger scale and also shows the distribution of a larger number of geological divisions. Take for example the oldest division represented on this map, which covers the southwestern part of the state and is given as the "Cincinnati Group, Trenton and Hudson." This terrain is composed of four distinct formations, viz.: the Trenton limestone (or whatever part of the Mohawkian series the Point Pleasant beds of Ohio may represent), the Eden shale and the Lorraine or Maysville and Richmond formations. These formations have never been differentiated and mapped in Ohio, although this has been done in Indiana by its Geological Survey. The next large division, the "Niagara Group," in southwestern Ohio, is composed of the Osgood beds, the West Union, Springfield and Cedarville limestones and the Hillsboro sandstone. No attempt has been made to map these divisions or even correlate them with the Niagara area of the northern part of the state and such correlation with the more eastern representatives in Ontaio and New York is very indefinite. The two divisions of the "Salina" and "Water Lime" in the northern part of the state which belong to what is now called the Monroe formation were badly confused and in general the supposed age quite

1 Geological Survey of Ohio, Report of progress in 1869, pp. 9, 10.

2 Fourth series, Bul. No. 7, Nov., 1905.

remote from the real one. The recent report on Monroe county, the southeastern one of Michigan, by the Geological Survey of that state, has added greatly to our exact knowledge of this formation. The writer has also collected considerable data in this state, Michigan, Ontario, and New York for a bulletin upon this formation. The "Corniferous limestone" is composed of the two distinct formations of the Columbus and Delaware limestones which have never been separately mapped. It may be mentioned in passing that Dr. Charles K. Swartz of Johns Hopkins University has in preparation a valuable monograph describing the stratigraphy and paleontology of these formations and the writer and his students have done something in this same line. The next large division, the "Waverly Group," in central Ohio, is composed of six clearly defined formations, viz.: the Bedford shale, Berea sandstone, Sunbury shale. Cuyahoga, Black Hand and Logan formations, no one of which has ever been mapped separately. It is also probable that there will be some change in the units of this series in the northern part of the state and perhaps in the southern as compared with those of central Ohio. The writer and his students have given considerable attention to the problem of the classification and description of the Waverly series. Finally, the area colored as the "Coal Measures" includes the upper portion of the Pottsville, the Allegheny, Connemaugh and Monongahela formations together with the Dunkard formation, the latter probably of Permian age. Although these formations are not mapped separately, still something has been done toward furnishing the data for such representation in tracing the various coal seams of the state. Certain ones, as for example the Upper Freeport, Pittsburg and Waynesburg coals indicate formation limits and the recent work of Dr. Bownocker and his assistant in tracing the Pittsburg coal will be of value in separating the Conemaugh and Monongahela formations. There also remain the subjects of glacial and physiographic geology which have become of great importance and interest in these later years. Concerning glacial geology much has been accomplished by the United States Geological Survey in this state as is shown in Leverett's Monograph entitled "Glacial formations and drainage features of the Erie and Ohio basins."

It is not the writer's intention to criticise in any way the work of the earlier members of the Ohio Geological Survey, and if any have formed that opinion they have missed entirely the aim of this paper. Indeed, on the contrary, he often wonders at the large amount of correct and valuable information which they brought together, hampered as they were financially, pressed for time, and often laboring under most discouraging conditions. The fidelity, perseverence and faithfulness of those men merit all honor.

Neither has the writer any criticism to make of the present survey. Its efficient chief has invariably furthered all the work which I have been able to undertake and patiently awaited results, which on account of numerous other duties are long delayed, and the relations with all the other members of the staff have always been pleasant. Nor has the writer any plan which he wishes to launch and so is availing himself of this opportunity for that purpose. He is simply attempting to state in a fair and impartial manner, as it appears to him, what stage has been reached in the description of the stratigraphic geology of this state.

There is, however, a very general misapprehension concerning the accuracy and degree of refinement reached in the stratigraphic geology of Ohio. The frequent question, "Well, have you finished your work for the survey?" is very tiresome, or the remark, "Why, I thought the geology of Ohio was finished." If I have any standing as a geologist, let me say once for all that $25,000, nay $50,000, wisely and economically administered will not then furnish Ohio with a similar wealth of accurate stratigraphic knowledge as that upon which the last geological map of New York or Pennsylvania is based.

Ladies and Gentlemen: The time has not yet arrived when we can consider that our knowledge of the geology of Ohio is about complete. It is still a far cry before she overtakes some of her sister states. Moreover, those same states at present are by no means idle. Look at New York! After almost seventy years of state investigation still appropriating $30,000 annually for geological work, with a permanent force of fourteen men and ten additional temporary assistants. Her magnificent set of geological reports is a source of pride to all her intelligent citizens and has made the name of New York familiar wherever geology is known. Nor is New York alone. The appropriation for geological work during the current year in Maryland is $10,000, in West Virginia $12,000, in Kentucky $10,000, in Indiana $7,000, in Michigan $8,000, in Illinois $15,000, in Iowa $5,000 and in Missouri $20,000. Probably in no state is the entire amount devoted to stratigraphic geology; but in each case a large proportion of the appropriation is alloted to that part of the subject.

I have attempted to show very briefly in these few minutes how the science of stratigraphic geology originated and developed. Likewise the attempt has been made to indicate in a general way what has been accomplished in Ohio in this science and *most of all* to emphasize the fact that it is not finished. If this last point has been made clear, in my judgment, this paper will not have been written in vain.

SUPERFICIAL DEPOSITS ALONG THE MISSISSIPPI

Gerard Fowke.

For the most part geologists, and others, who have studied the loess formation in the states bordering on the Missouri and Mississippi rivers, concur in attributing the deposit to glacial floods which attained their maximum when the ice was melting along the front more rapidly than it could advance from the north. The material is clay and sand, in varying proportions, modified more or less by local detritus. Considering the ease with which it is excavated, its power to withstand pressure or erosion is something remarkable. This quality is especially noticeable along the Missouri bluffs; below that river it becomes less resistant. On the upper portions of the two great rivers, the loess is heavy, forming high bluffs and spreading far inland; southward, it progressively diminishes in extent and thickness. This fact, reinforced by similar conditions observable along tributary streams, have enabled students to determine that coincident with the greatest extension of the glacier, and lasting until the present time, there was a marked subsidence of land, relative to sea-level, in the Mississippi Valley; the subsidence being more pronounced toward the north. The current of southward flowing streams was retarded, and the sediment-laden waters began to free themselves from silt, by precipitation, almost at once upon their emergence from the ice. There was still sufficient movement, however, to carry the finer suspended matter until sea-level was reached.

The limit of the ice-sheet, in southern Illinois, was along the hills bordering Big Muddy on the north, almost to the mouth of that stream, as it passed into the Mississippi at Grand Tower; thence northward, closely following the line of the larger stream, nearly to Alton; thence, crossing into Missouri, it skirted the north side of the Missouri river nearly to the middle of the state. On the bluffs at the mouth of the Missouri, on the south side, is considerable glacial drift; until very recently it has been uncertain whether it marked an extension of the glacier, or whether it is due to floating ice. Within the past year, the excessive rainfall has enabled two little streams to carry away enough overlying gravel to reveal two small areas of typical till; so it is now certain that the main body of ice shut off the Missouri and consequently acted as a temporary dam. Further, Brodhead records the occurrence of gravel, which he supposed to be of glacial origin, on the highest point in St. Louis county, about 350 feet above the Mississippi. It seemed possible, from these facts, that the ice had attained sufficient height to back the water up the Missouri a long distance and form a temporary lake. But Brodhead's gravel beds prove to be of local origin, while the first-mentioned drift reaches but little, if any, more than 100 feet above the stream, and the ice-dam did not hold for a period that allowed any channel to be made to the south of it; so another cause must be sought for the loess deposits in the vicinity.

In and around St. Louis the loess forms a cap, covering nearly all the early formations. While it is thin on hilltops and thicker in valleys by reason of erosion and re-deposition on uneven ground, yet it is singularly regular over many square miles. Reports of railway cuttings, wells, and other excavations, contain numerous references to "loess 12 or 14 feet thick." It is from 6 to 8 feet thick on a plateau nearly 350 feet high; and is not more than 20 feet in most of the county unless near the foot of a slope. This means a depth of water that would submerge hills at the level indicated, and lowering so rapidly in the end as to uncover all the territory within a comparatively short time.

Worthen says that in Jackson county (Illinois), the loess occupies only a narrow belt on the top of the river bluffs; and in Union county, next south of Jackson it was found at only one point and that below the top of the bluff.

Shumard notes the presence at Wittenberg, Missouri, of a mass of granite weighing several tons; and thinks this is evidence of a ledge of eruptive rock in the neighborhood.

It should be stated that Big Muddy separates Jackson from Union county, and that Wittenberg lies opposite to the old mouth; being about eighty miles south of St. Louis. Between these two points are Rock Creek, twenty miles south of the city, in whose valley the loess (modified by local drift) is one hundred feet high; and Plattin creek, forty miles south, where it covers a slope at an elevation of eighty feet.

It seemed plausible to suppose that a prolongation or spur of the glacier might have reached from the Big Muddy to the Missouri side, thus choking the Mississippi and allowing the water to stand at a level sufficient to drown most of the country above. Additional color was given to this supposition by the gorge at Grand Tower, just below Wittenberg. Here, the river flows in a narraw, rock-bound channel, over a solid rock bottom, while on the Illinois side is a valley fully three miles wide, of alluvial silt subject to overflow in great freshets. But the granite proves to be only a boulder, lying in a small ravine a few feet above the river's ordinary level, and it may have come in with an ice floe at any time. And there is not a trace of evidence on either side of the river, that the glacier had even reached the lowland. This was an additional problem, instead of an explanation; for there was St. Louis and Cairo only sand and silt are found along the valley, a feature that apparently indicates a drainage no more vigorous also to be sought, a reason why a stream should be turned from a wide, deep channel, into a narrow gorge which lay higher than the stream itself.

At Thebes, near Cairo, is a similar gorge; for fifteen miles there are bluffs along both sides of the river which is bordered only by narrow strips of alluvial land, while at one place, "The Grand Chain," masses of rock projecting above the surface compel pilots to hold their boats in a very narrow channel. At Cape Girardeau, a few miles above, the loess caps a hill fully 170 feet above the level of the river bank. Here, again was an obstructed ancient channel; and the question of a solid ice-dam was answered in the negative at once, for the greatest southern extension of the glacier was many miles above. It was deemed possible, though not at all probable, that icebergs or floes may have found some obstacle to hold them at this point until they had formed a hard pack. Beginning near Cape Girardeau is a swamp fully three miles in width and terminating more than fifteen miles below, which was the former course of the Mississippi. Bluffs border it on both sides, in most places precipices of solid limestone. As at Grand Tower, no trace of glacial drift could be found above high-water mark; besides, the valley of the swamp is too wide and too deep for ice to have jammed. Below here, are reached the extensive swamps that fill the former prolongation northward of the Gulf of Mexico; and farther research was useless.

It thus was evident that by no possibility could loess deposits south of the Missouri river be due to a dam of either earth or ice; and some other explanation must be worked out and investigated.

Wright has calculated, and brought forward proof of his figures, that at its greatest discharge during the melting of the continental glacier, the Missouri reached a flood height of at least two hundred feet.

On the Illinois river, sixty miles above its mouth, are bluffs of loess fully one hundred feet high, proving this stream also subject to great floods.

At the same time the Mississippi was draining a large area of ice-covered country.

The border of the ice-sheet being in this region along a line approximately east and west, these rivers would discharge their immense volumes of summer water at practically the same time, and not with intervals between flood height, as is now the case. It is quite probable that the rise in the Mississippi, when reinforced by that from the Illinois, fully equalled that in the Missouri. When all these waters united, in a channel not much wider in many places than in one of the three, it follows that, either the current must flow with great velocity or the water must rise to a level greater below the junction than it would naturally. Bearing upon this point is an observation by Leverett, who says that "between than at the present day. Yet it seems probable that at times the volume of water greatly exceeded that now discharged through the valley."

We have seen why the volume of water should be greater than at present; but as yet have given no reason why the flow should not be correspondingly vigorous. That it was greater, is evident from the loess at Cape Girardeau; and as this is near the wide flood plain on which the water could rush out as into a sea, the obstruction that would hold it back must be close at hand.

Leverett says, again, "The Ohio at one time discharged either wholly or in part through the 'Cache Valley,' which crosses southern Illinois a few miles north of the present course of the Ohio." The "clay deposit stands only about seventy-five feet above the present stream. [It] has sufficient depth to extend to river level, and it may extend much lower." The "Grand Chain of the Ohio," crosses the river below the point of divergence of the old channel from the one now occupied by the river.

Clearly, we have here a condition similar to that at Thebes. At the time under consideration the Ohio received all the glacial discharge east of that flowing into the Illinois and Mississippi, in addition to the floods from its southern tributaries swollen by rainfall greater than we now know. These torrents flowed through Cache valley, over a bottom which is now seventy-five feet above river level. The water thus discharged would equal or perhaps exceed that coming from the north; each great river would retard the flow of the other, and in the comparatively sluggish currents above their junction sediment would come to rest. This condition prevailed until the ancient beds, excavated in geological ages antedating the glacial period, were filled up. At Grand Tower and at Thebes, the Mississippi when it was once more free to flow southward without hindrance found the clefts through which it now flows, lower than the silt in its old channel. So the Ohio Cache valley was filled to a level higher than the crevices in "Grand Chain," and the water made its way through these. Probably the Tennessee had discharged directly into the Mississippi; but this region has not been fully studied.

The sharp peaks, bluffs, and ridges of loess on the upper rivers are the counterparts of the broad bottom lands along the lower Ohio. In the one case, the land is high enough above sea-level to permit aerial sculpturing; in the other, erosion can not act because the gradient is almost at the base line. All, alike, are due to sediments carried by glacial floods; the components being the various earthy materials which ice and water have ground from rocks, picked up from soils, mingled by ceaseless grinding and washing, and finally carried in suspension until in quiet waters behind projecting hills, or in lake-like expanses of over-flowing back-water, they settle to the bottom to form picturesque landscapes where carved by winds and frost, or stretch out in plains of wonderful fertility where these agencies do not erode them.

Pteridophyta and Spermatophyta found in Auglaize County, Ohio

A. WETZSTEIN

In the following list c after a species name indicates common; l, local; r, rare; s, sporadic.

SUBKINGDOM PTERIDOPHYTA

1. OPHIOGLOSSACEAE.

Botrychium dissectum Spreng., s.
ternatum Sw., not c.
virginianum Sw., c.
Ophioglossum vulgatum L., found only in three places.

2. OSMUNDACEAE.

Osmunda cinnamomea L.. I obtained one specimen from Prof. Young as found in a woods northeast of St. Marys. Doubt its presence in Auglaize county.
Osmunda regalis L., r.

3. POLYPODIACEAE.

Adiantum pedatum L., c.
Asplenium acrostichoides Sw., r.
angustifolium Michx., not c.
filix-foemina Bernh., not r.
Cystopteris fragilis Bern., c.
Dryopteris acrostichoides Kuntze.,c
noveboracensis A. Gray, l.
spinulosa Kuntze., s.
Dryopteris spinulosa dilatata Underw., r.
spinulosa intermedia Underw.,c
thelipteris A. Gray., not c.
Onoclea sensibilis L., c.
Phegopteris dryopteris robertiana, very r.
hexagonoptera Fee, c.
phegopteris Underw.. c.
Pteris aquilina L.. l.

4. EQUISETACAE.

Equisetum arvense L., c.
hyemale L., c.
laevigatum A. Br., not c.
Equisetum pratense Ehrh., not c.
robustum A. Br., r.
silvaticum L., not c.

SUBKINGDOM SPERMATOPHYTA

I CLASS GYMNOSPERMAE

5. PINACEAE.

Juniperus communis L., s.
virginiana L., l.
sabina L., a few shrubs in a garden at St. Marys, O., now destroyed a few years ago, in spite of my endeavor to save them.
Larix laricina Koch. r.
Pinus echinata Mill.,r. Elmgrove cemetery, St. Marys, O.
resinosa Ait., one tree, Elmgrove cemetery.
Picea canadensis B. S. P., not c.
Thuja occidentalis L., not r.
Tsuga canadensis Carr. c.

II CLASS ANGIOSPERMAE

a Monocotyledones

6. TYPHACEAE.

Typha angustifolia L., not very c.
Typha latifolia L., c.

7. SPARGANIACEAE.

Sparganium androcladum Morong., c.
Sparganium eurycarpum Engelm., not c.

8. NAJADACEAE.

Najas flexilis Rost and Schmidt, c.
Potamogeton amplifolius Tuckerm., r.
crispus L., r. St. Marys Reservoir.
foliosus Raf., c.
foliosus niagarensis Morong , c.
Potamogenton Hillii. one plant, St. Marys Reservoir.
lonchites Tuckerm., r.
natans L., c.
pectinatus L., c.
pusillus L., not c.

9. ALISMACEAE.

Alisma plantago-aquatica L., c.
Lophotocarpus calycinus J. G. Smith., c.
Sagittaria latifolia Willd., c.
longiloba Englem., c.
longirostra J. G. Smith., not c

10. GRAMINEAE.

Agrostis alba L., very c.
exarata Trin., l.
intermedia Scribn., not c.
perennans Tuckerm., c.
Alopecurus geniculatus L., l.
Andropogon furcatus Muhl., c.
scoparius Michx., r.
Avena sativa L., escaped, s.
Bromus asper Murr., c.
ciliatus purgans L., not c.
breviaristatus Buckl., r.
racemosus L., c.
secalinus L., c.
tectorum L., l.
Calamagrostis canadensis Beauv., l
Dactylis glomerata L., c.
Danthonia spicata Beauv., very c.
Cinna arundinacea L., c.
Chrysopogon avenaceus Benth., l.
Eatonia obtusata A. Gray., r.
pennsylvanica A. Gray., locally c.
Eleusine indica Gaertn., c.
Elymus canadensis L., c., locally.
striatus Willd., c.
virginicus L., c.
glaucus., r.
Festuca elatior L., not c.
gigantea Vill., l.
nutans Willd., c.
Homalocenchrus oryzoides Poll., c.
virginicus Britton., c.
Hystrix hystrix Millsp., very c.
Ixophorus glaucus Nash., c.
italicus Nash., l.
Ixophorus viridis Nash., not c.
Korycarpus diandrus Kuntze., l., woods near St. Mary's Reservoir, north.
Milium effusum L. c.
Muhlenbergia diffusa Schreb., c.
mexicana Trin., c.
Panicularia americana.MacM.,not c
nervata Kuntze., not c.
fluitans Kuntze., c. locally.
Panicum capillare L., c.
capillare Gattingeri Nash., c.
crus-galli L., very c.
dichotomum, r.
macrocarpon., not c.
proliferum Lam., c.
pubescens Lam., c.
virgatum L., r.
Walteri Pursh., l.
Phalaris arundinacea L., l.
Phleum pratense L., very c.
Poa alsodes A. Gray., l.
annua L., not c.
buckleyana Nash., r.
brevifolia Muhl., r.
compressa L., c.
pratensis L., c.
silvestris A. Gray, not c.
trivialis L., l.
Secale cerele L., escaped, s.
Spartina cynosuroides Willd., not c
Sporobolus neglectus Nash not c.
vaginaeflorus Wood., c.
Syntherisma linearis Nash., not c.
sanguinalis Nash., very c.

11. CYPERACEAE.

Carex albursina Sheldon, l.
aquatilis Wahl., c.
arenaria L., not c.
aristata B. Br.
Asa-Grayi Bailey., l.
cephaloidea Dewey, r.
cephalophora Muhl., c.
comosa Boott., l.
conjuncta Boott., not c.
crinita Lam.
cristatella Britton., c.
crus-corvi Shuttlw., l.
Davisii Schwein & Torr., r.
deweyana Schwein., c.
digitalis Willd., not c.
Frankii Kunth., c.
gracillima Schwein., c.
glaucodea Tuckerm., r.
granularis Muhl., c.
granularis Shriveri Britton., l.
grisea Wahl., c.
hitchcockiana Dewey., r.
hystricina Muhl., very c.
Jamesii Schwein., c.
lanuginosa Michx., l.
laxiflora Lam., c.
laxiflora blanda Boott., c.
laxiflora patulifolia Carey, l.
lupulina Muhl., l.
muhlenbergii Schk., r.
muskin gumensis Schwein., c.
pennsylvanica Lam., very c.
plantaginea Lam., l.
platyphylla Carey, r.
pubescens Muhl., c.
retroflexa Muhl., c.

riparia Curtis, l.
rosea Schk., not c.
scoparia Schk., r.
setacea Dewey, not c.
shortiana Dewey, locally c.
sparganioides Muhl., not c.
squarrosa L., l.
stipata Muhl., r.
stricta Lam., l.
styloflexa Buckley., not c.
tribuloides Wahl., c.
tribuloides Bebbii Bailey, s.
tribuloides moniliformis Britton., not r.
triceps Michx., c.
Tuckermani Dewey, l.
varia Muhl., not c.
virescens Muhl., c.
vulpinoidea Michx., c.
walteriana Bailey, not c.
xanthocarpa Bicknell, not c.
xanthocarpa annectens Bicknell, r.
Cyperus diandrus Torr., not c.
erythrorhizos Muhl., c.
esculentus L., c.
ferox, r.
Engelmanni Steud., not c.
refractus Engelm., r.
rivularis Kunth., c.
speciosus Vahl., not r.
strigosus L., c.
strigosus robustior, s.
Nuttallii, only a few specimens.
Dulichium arundinaceum Britton, r
Eleocharis acicularis Br., l.
acuminata Nees., not c.
Engelmanni, r.
intermedia Schult., not c.
microcarpa, r.
melanocarpa Torr., not c.
ovata R. & S., c.
palustris Br., common l.
tenuis Schultes, not c.
tuberculosa Br., not c.
Kyllinga pumila Michx., l.
Scirpus atrovirens Muhl., not r.
cyperinus Kunth., l.
lacustris L., c.
lineatus Michx., very c.
robustus Pursh., s.

12. ARACEAE.

Acorus calamus L., l.
Arisaema dracontium Schott, not r
Arisaema tripyllum Torr., c.
Spathyema foetida Raf., l.

13. LEMNACEAE.

Lemna minor L., not c.
trisculca L., c.
Spirodela polyrhiza Schleid., c.

14. COMMELINACEAE.

Tradescantia reflexa Raf., found only in one place, along a ditch near St. Mary's Reservoir.
Tradescantia virginiana L., c.

15. PONTEDERIACEAE.

Heteranthera dubia MacM., not c.

16. JUNCACEAE.

Juncus canadensis Gay., c.
tenuis Wild., very c.
Juncoides campestre Kuntze., c.

17. MELANTHACEAE.

Uvularia grandiflora J. E. Smith., c.

18. LILIACEAE.

Allium canadense L., c.
cepa L., escaped, along canal.
cernuum Roth., l.
tricoccum Ait., not r.
Erythronium albidum Nutt., c.
americanum Ker., l.
Hemerocallis fulva L., locally c.
Lilium canadence L., not r.
Ornithogalum umbellatum L., r.
Quamasia hyacinthina Britton., c.
hyacinthina alba Wetzstein., 2 specimens.

19. CONVALLARIACEAE.

Asparagus officinalis L., s.
Polygonatum biflorum Ell., c.
commutatum Dietr., l.
Trillium erectum L., c.
grandiflorum Salisb., c.
Trillium recurvatum Beck., c.
sessile L., c.
Unifolium canadense Green., r., Wapakoneta, O.
Vagnera racemosa Morong., c.
stellata Morong., l.

20. SMILACEAE.

Smilax ecirrhata L. Wats., c.
glauca Walt., not c.
herbacea L., c.
Smilax rotundifolia L., c.
spinulosa J. E. Smith., r.
tamnifolia Michx.
pseudo-china L., r.

21. AMARYLLIDACEAE.

Hypoxis hirsuta Coville. l.

22. DIOSCOREACEAE.

Dioscorea villosa L., c.

23. IRIDACEAE.

Iris hexagona Walt., only one place: wet meadow east of St. Marys.
versicolor L., c.
Sisyrinchium angustifolium Mill., c
graminoides Bicknell, not r.

24. ORCHIDACEAE.

Aplectrum spicatum B. S. P., very r
Cypripedium hirsutum Mill., r., l.
Habenaria bracteata R. Br., not r.
Habenaria leucophaea A. Gray., l.
psycodes A. Gray, l.
Orchis spectabilis L., r.

b Dicotyledones

1 Series: Choripetalae

25. SAURURACEAE.

Saururus cernuus L., c.

26. JUGLANDACEAE.

Hicoria laciniosa Sarg., not c., l.
microcarpa Britton, c.
minima Britton, not r.
Hicoria ovata Britton, not r.
Juglans nigra L., c.

27. SALICACEAE.

Populus alba L., s.
balsamifera L., not r.
deltoides Marsh., c.
dilatata L., l.
grandidentata Michx., l.
heterophylla L., s.
tremuloides Michx., c.
Salix alba L., c.
coerulea Koch., r.
vitellina Koch., c.
Salix amydaloides Anders, not r.
cordata Muhl., c.
cordata angustata Anders, l.
discolor Muhl., very c.
humiles Marsh., one shrub only.
lucida Muhl., l.
nigra Marsh., c.
fluviatilis Nutt. (interior), c.

28. BETULACEAE.

Carpinus caroliniana Walt., c.
Corylus americana Walt., c.
Ostrya virginiana Willd., c.

29. FAGACEAE.

Fagus americana Sweet., c.
Queseus alba L., c.
acuminata Sarg., s.
coccinea Wang., not c.
digitata Sudw., s.
imbricaria Michx., not r.
macrocarpa Michx., c.
Quercus marylandica Muench., s.
Michauxii Nutt., not c.
platanoides Sudw., s.
prinoides Willd., only one shrub ,now destroyed.
prinus L., s.
palustrus DuRoi., s.
rubra L., c.
velutina Lam., s.

30. ULMACEAE.

Celtis occidentalis L., c.
Ulmus americana L., c.
Ulmus fulva Michx., c.

31. MORACEAE.

Humulus lupulus L., not c.
Morus rubra L., not r.
Morus alba L., a few trees only, cultivated.
Toxylon pomiferum Raf., not r.

32. URTICACEAE.

Adicea pumila Raf., c.
Boehmeria cylindrica Willd., c.
Parietaria pennsylvanica Muhl., c.
Urtica dioica L., l
gracilis Ait., not c.
Urticastrum divaricatum Kuntze., c

33. SANTALACEAE.

Comandra umbelata Nutt., l.

34. ARISTOLOCHIACEAE.

Aristolochia serpentaria L., c.
Asarum canadense, l.
reflexum ambiguum Bicknell., c.

35. POLYGONACEAE.

Fagopyrum fagopyrum Karst., escaped.
Polygonum aviculare L., very c.
arifolium L., l.
emersum Britton, c.
erectum L., l.
convolulus L., c.
hydropiper L., l.
hydropiperoides Michx., c.
hydropiperoides Macouni Small, r.
incarnatum Ell., c.
lapathifolium L., c.
lapathifolium nodosum Small, found few plants 1902 along the Canal south of St. Marys, O. In 1903 the whole canal north of town was filled with it, but in 1904 it had almost disappeared.
Polyonum pennsylvanicum L., not c
persicaria L., c.
punctatum Ell., c.
punctatum robustior Small, s.
ramosissimum Michx., s.
sagittatum L., l.
scandens L., not r.
virginianum L., c.
Rumex acetosella L., l.
altissimum Wood, l.
crispus L., very c.
obtusifolius L., c.
verticillatus L., l.

36. CHENOPODIACEAE.

Atriplex hastata L., very c.
patula L., c.
Chenopodium album L., very c.
album viride Mog., s.
leptophyllum Nutt., r.
Chenopodium urbicum L., not r.
Salsola tragus L., found only in one place.

37. AMARANTHACEAE.

Acnida tamariscina tuberculata Uline and Bray, c.
Amaranthus graecizans L., c.
Amaranthus hybridus L., c.
hybridus paniculatus Uline & Bray, c.
retroflexus L., very c.

38. PHYTOLACCACEAE.

Phytolacca decandra L., c.

39. AIZOACEAE.

Mollugo verticillata L., l.

40. PORTULACACEAE.

Claytonia virginica L., very c.
Portulaca grandiflora Tourn., escaped, r.
oleracea L., very c.

41. CARYOPHYLLACEAE.

Agrostemma githago L., s.
Alsine longifolia Britton, c.
graminea Britton, l.
media L., very c.
Arenaria serpyllifolia L., s.
Cerastium longipedunculatum Muhl., c.
Cerastium viscosum L., c.
vulgatum L., s.
Moehringia lateriflora Fenzl., c.
Saponaria officinalis L., escaped.
Silene antirrhina L., l.
noctiflora L., r.
virginica L., c.

42. NYMPHAEACEAE.

Castalia adorata Wood & Wood, not rare.
Nymphaea advena Soland., l.
Nelumbo lutea Pers., in a pond near canal St. Marys, O.

43. CERATOPHYLLACEAE.

Ceratophyllum demersum L., c.

44. MAGNOLIACEAE.

Liriodendron tulipifera L.
Magnolia acuminata L.

45. ANONACEAE.

Asimina triloba Dunal., c.

46. RANUNCULACEAE.

Actaea alba Mill., not r.
Anemona canadensis L., c.
quinquefolia L., l.
virginiana L., c.
Aquilegia canadensis L., l.
Batrachium divaricatum Wimm., l.
Caltha palustris L., s.
Clematis viorna L., r.
virginiana L., not r.
Delphinium Ajacis L., escaped, s.
consolida L., s.
Hepatica acuta Britton, l., r.
hepatica Karst., c.
Hydrastis canadensis L., not c.
Ranunculus abortivus L., c.
acris L., s.
delphinifolius Torr., l.
hispidus Michx., c.
Purshii Richards, very r.
recurvatus Poir., c.
repens L., c.
sceleratus L., l.
septentrionalis Poir., s.
Syndesmon thalictroides Hoffmg., s
thalictroides petiolata Kellerman, s.
Thalictrum dioicum L., c.
purpurascens L., c.

47. BERBERIDACEAE.

Berberis vulgaris L., s.
Caulophyllum thalictroides Michx., l.
Jeffersonia diphylla Pers., c.
Podophyllum peltatum L., c.

48. MENISPERMACEAE.

Menispermum canadense L., c.

49. LAURACEAE.

Benzoin benzoin Coulter, c.
Sassafras officinale Nees., very r.

50. PAPAVERACEAE.

Bicuculla cucullaria Millsp., c.
Papaver rhoeum L., very r.
Sanguinaria canadensis L., c.
Argemone alba, 2 plants.

51. CRUCIFERAE.

Arabis dentate T. & G., l.
glabra Bernh., r.
laevigata Poir., c.
Barbarea barbarea MacM., c.
Brassica arvensis B. S. P., c.
campestris L., c.
napus L., s.
nigra Koch, very r.
Bursa bursa-pastoris Britton, very c
Camelina sativa Crantz, s.
Cardamine bulbosa B. S. P., l.
pennsylvanica Muhl., l.
purpurea Britton, c.
Dentaria heterophylla Nutt., r.
laciniata Muhl., c.
Lepidium apetalum., not r.
campestre R. Br., l.
virginicum L., very c.
Roripa armoracia A. S. Hitchcock, locally c.
hispida Britton, not c.
palustris Bess., c.
Raphanus sativus L., sporadically escaped.
Sisymbrium officinale Scop., very c.

52. CRASSULACEAE.

Penthorum sedoides L., c.
Sedum acre L., sporadically escaped.
Sedum telephioides Michx., l.
ternatum Michx., locally c.

53. SAXIFRAGACEAE.

Heuchera americana L., c.
Mitella diphylla L., locally c.
Philadelphus coronarius L., sporadically.
Philadelphus inodorus L., one shrub near railroad to New Bremen.
Saxifraga pennsylvanica L., l.

54. GROSSULARIACEAE.

Ribes aureum Pursh., c. in gardens
cynosbati L., c.
Ribes floridum L'Her., c.

55. PLATANACEAE.

Platanus occidentalis L., not r.

56. ROSACEAE.

Agrimonia mollis Britton, not c.
parviflora Soland., c.
striata Michx., c.
Fragaria americana Britton, l.
virginiana Duchesne, c.
Geum canadense Jacq., c.
vernum T. & G., c.
virginianum L., c.
Rosa carolina L., c.
humilis Marsh., c.
humilis lucida Best., l.
humilis villosa Best., l.
setigera Michx., c.
Rubus canadensis L., c.
laciniatus Willd., very r.; found only two specimens in woods about two miles N. E. of St. Marys.
occidentalis L., c.
villosus Ait., c.

57. POMACEAE.

Amelanchier canadensis Medic., s.
Crataegus coccinea L., c.
crus-galli L., c.
macracantha Lodd., s.
mollis Scheele., c.
punctata Jacq., not r.
punctata canescens Britton, l.
Crataegus rotundifolia Borck., s.
tomentosa L., c.
Malus coronaria Mill., c.
angustifolia Ait., l.
malus Britton, s.

58. DRUPACEAE.

Amygdalus persicaria L., s.
Prunus americana Marsh., c.
cerasus L., s.
Prunus serotina Ehrh., c.
virginiana L., l.

59. CAESALPINACEAE.

Cassia marylandica L., l.
Cercis canadensis L., c.
Gleditsia triacanthos L., c.
Gymnocladus dioica Koch, locally c.

60. PAPILIONACEAE.

Apios apios MacM., l.
Falcata comosa Kuntze, c
Lathyrus myrtifolius Muhl., l.
palustris L., not r.
Lespedeza frutescens Britton, l.
violacea Pers., c.
Medicago lupulina L., c.
sativa L., l.
Meibomia canadensis Kuntze, c.
canescens Kuntze, s.
bracteosa Kuntze, c.
Dillenii Kuntze, l.
glabella Kuntze, not c.
Meibomia grandiflora Kuntze, c.
nudiflora Kuntze, c.
paniculata Kuntze, c.
pauciflora Kuntze, r.
Melilotus alba Desv., c.
officinalis Lam., locally c.
Robinia pseudacacia L., c.
Trifolium hybridum L., c.
pratense L., c.
repens L., very c.

61. GERANIACEAE.

Erodium cicutarium L'Her., r.
Geranium maculatum L., c.

62. OXALIDACEAE.

Oxalis cymosa Small, l.
stricta L., c.
Oxalis violacea L., l.

63. LINACEAE.

Linum usitatissimum L., s.

64. RUTACEAE.

Ptelea trifoliata L., not r.
Xanthoxylum americanum Mill., c.

65. POLYGALACEAE.

Polygala verticillata L., locally c.
ambigua, with the type.

66. EUPHORBIACEAE.

Acalypha virginica L., c.
Euphorbia corollata L., c.
cyparissias L., l.
maculata L., localy very c.
Euphorbia marginata Pursh., locally abundant.
nutans Lag., c.
obtusata Pursh., l.

67. CALLITRICHACEAE.

Callitriche palustris L., s.

68. LIMNANTHACEAE.

Floerkea proserpinacoides Willd., c.

69. ANACARDIACEAE.

Rhus glabra L., c.
Rhus radicans L., c.

70. ILICACEAE.

Ilex verticillata tenuifolia A. Gray., r.

71. CELASTRACEAE.

Celastrus scandens L., c.
Euonymus atropurpureus Jacq., c.
obovatus Nutt., l.

72. PYROLACEAE.

Pyrola rotundifolia L., l.

73. STAPHYLEACEAE.

Staphylea trifolia L., c.

74. ACERACEAE.

Acer negundo L., s.
rubrum L., c.
Acer saccharinum L., c.
saccharum Marsh, l.

75. HIPPOCASTANACEAE.

Aesculus glabra Willd., c.

76. BALSAMINACEAE.

Impatiens aurea Muhl., l.
Impatiens biflora Walt., c.

77. VITACEAE.

Parthenocissus quinquefolia Planch., c.
Vitis aestivalis Michx., c.
Vitis bicolor Le Conte., s.
vulpina L., c.

78. TILIACEAE.

Tilia americana L., c.

79. MALVACEAE.

Abutilon abutilon Rusby., c.
Althaea rosea Cav., locally abundant.
Hibiscus militaris Cav., l.
trionum L., locally c.
Malva rotundifolia L., c.
sylvestris L., l.
Sida spinosa L., c.

80. HYPERICACEAE.

Hypericum maculatum Walt., c.
mutilum L., l.
Hypericum perforatum L., c.
Triadenum petiolatum Britton, r.

81. VIOLACEAE.

Cubelium concolor Raf., c.
Viola cucullata Ait., s.
labradorica Schrank, l.
obliqua Hill, c.
obliqua alba Wetzstein, one place only at canal north of St. Marys.
Viola palmata L., c.
pedatifida Don., one place only east of St. Marys.
pubescens Ait., c.
rostrata Pursh., l.
Viola sagittata Ait., s.
scabriuscula Schwein, l.
Viola sororia Willd., l.
striata Ait., c.

82. THYMELACEAE.

Dirca palustris L., l, not r.

83. LYTHRACEAE.

Decodon verticillatus Ell., l.
Lythrum alatum Pursh., c.
Lythrum alatum albidum Wetzstein, one place only along railroad to Celina, O.

84. ONAGRACEAE.

Chamaenerion angustifolium Scop., s.
Circaea lutetiana L., c.
Epilobium adenocaulon Haussk., s.
coloratum Muhl., c.
Gaura biennis L., l.
Isnardia palustris L., c.
Ludwigia polycarpa Short and Peter, c.
Onagra biennis Scop., c.

85. HALORAGIDACEAE.

Myriophyllum spicatum L., l.

86. ARALIACEAE.

Aralia racemosa L., localy abundant.
Panax quinquefolium L., s.

87. UMBELLIFERAE.

Angelica atropurpurea L., l.
Chaerophyllum procumbens Crantz, c.
Cicuta bulbifera L., c.
maculata L., l.
Conium maculatum L., s.
Daucus carota L., c.
Deringa canadensis Kuntze, c.
Erigenia bulbosa Nutt, locally c.
Foeniculum foeniculum Karst, s.
Heracleum lanatum Michx., l.
Pastinaca sativa L., c.
Pimpinella integerrima A. Gray, c.
Sanicula canadensis L., c.
gregaria Bicknell, locally c.
marylandica L., c.
Thaspium barbinode Nutt, c.
barbinode angustifolium Coult. and Rose. l.
trifoliatum aureum Britton, c.
Aegopodium podagraria L., r.

88. CORNACEAE.

Cornus amonum Mill., c.
asperifolia Michx., l.
candidissima Marsh, c.
Cornus florida L., not r.
stolonifera Michx.; l.

2 Series: Gamopetalae

89. MONOTROPACEAE.

Monotropa uniflora L., r.

90. PRIMULACEAE.

Naumburgia thyrsiflora Duby., l.
Lysimachia nummularia L., c.
Samolus floribundus H. B. K., c.
Steironema ciliatum Raf., c.
lanceolatum A. Gray, c.
quadriflorum Hitchc., l.

91. OLEACEAE.

Chionanthus virginica L., s.
Fraxinus americana L., c.
Fraxinus quadrangulata Michx., s.
Ligustrum vulgare L., l.

92. GENTIANACEAE.

Gentiana Andrewsii Griseb., c.
Gentiana crinita Froel., one place only; meadow at east side of Reservoir.

93. APOCYNACEAE.

Apocynum androsaemifolium L., c.
cannabinum L., c.
pubescens R. Br., very rare; only one place at foot of high bank of canal north of St. Marys, O.
Vinca minor L., c. locally.

94. ASCLEPIADACEAE.

Asclepias exaltata Muhl., s.
incarnata L., c.
quadrifolia Jacq., l.
Asclepias purpurascens L., l.
syriaca L., c.
tuberosa L., c.

95. CONVOLULACEAE.

Convolvulus arvensis L., locally c.
japonicus Thunb., l.
sepium L., c.
spithamaeus L., s.
Convolvulus repens, l.
Ipomoea hederacea Jacq., locally c.
pandurata Meyer, c.
purpurea Roth, l.

96. CUSCUTACEAE.

Cuscuta cephalanthi Engelm, l.
compacta Juss., l.
Cuscuta Gronovii Willd., l.

97. POLEMONIACEAE.

Phlox divaricata L., c.
divaricata candida Wetz., s.
maculata L., l.
Phlox paniculata L., l.
Polemonium reptans L., c.
reptans album Wetzstein, s.

98. HYDROPHYLLACEAE.

Hydrophyllum appendiculatum Michx., c.
macrophyllum Nutt, l.
Hydrophyllum virginicum L., c.
Phacelia Purshii Buckl., l.

99. BORAGINACEAE.

Cynoglossum officinale L., l.
Lappula lappula Karst, c.
virginiana Greene, c.
Lithospermum arvense L., c.
latifolium Michx., l.
Mertensia virginica DC., c.
Myosotis palustris Lam., s.
Symphytum officinale L., l.
Onosmodium virginianum DC., s.

100. VERBENACEAE.

Lippia lanceolate Michx., c.
Verbena angustifolia Michx., s.
  hastata L., c.
Verbena urtifolia L., c.
  urticifolia riparia Britton, s.

101. LABIATAE.

Agastache nepetoides Kuntze, l.
  scrophulariaefolia Kuntze, l.
Blephilia hirsuta Torr, c.
Colinsonia canadensis L., c.
Glecoma hederacea L., c.
Hedeoma pulegioides Pers., c.
Koellia pilosa N., r.
  virginiana MacM., locally c.
Lamium amplexicaule L., l.
  maculatum L., locally c.
Leonurus cardiaca L., c.
Lycopus americanus Muhl., c.
  rubellus Moench., l.
  virginicus L., not r.
Mentha alopecuroides Hull, s.
  citrata Ehrh., l.
  sativa L., not c.
  spicata L., c.
  canadensis L., c.
Monarda clinopodia L., l.
  fistulosa L., c.
Nepeta cataria L., c.
Physostegia virgeniana Benth., l.
Prunella vulgaris L., c.
Salvia officinalis L., sporadically escaped.
Scutellaria cordifolia Muhl., c.
  galericulata L., c.
  lateriflora L., c.
  lateriflora albida Wetzstein, s.
  nervosa Pursh., not c.
Stachys aspera Michx., l.
  cordata Riddell, l.
  palustris L., not c.
  tenuifolia Willd., l.
Teucrium canadense L., c.
  occidentale A. Gray, l.

102. SOLANACEAE.

Datura tatula L., l.
Lycium vulgare Dunal, c.
Lycopersicon lycopersicon Karst, escaped.
Physalis heterophylla Nees., l.
  philadelphica Lam., c.
  pruinosa L., l.
Physalis virginiana Mill, l.
  pubescens L., c.
Physalodes physalodes Britton, l.
Solanum carolinense L., local, not c.
  dulcamara L., l.
  nigrum L., c.
  tuberosum L., escaped.

103. SCROPHULARICEAE.

Afzelia macrophylla Kuntze, l.
Collinsia verna Nutt, locally c.
Chelone glabra L., not c.
Gerardia besseyana Britton, only one place, at N. E. shore of Reservoir.
  tenuifolia Vahl., localy c.
  tenuifolia asperula A. Gray, with the type.
Gratiola virginiana L., c.
Ilysanthes gratioloides Benth., l.
Leptandra virginica Nutt, l.
Linaria linaria Karst, c.
Mimulus alatus Soland, l.
  ringens L., l.
Pedicularis canadensis L., l.
  lanceolate Michx., l.
Pentstemon canescens Britton, r.
Verbascum blattaria L., c.
  thapsus L., c.
Veronica arvensis L., c.
  officinalis L., c.
  peregrina L., l.
  scutellata L., c. locally.
  serpyllifolia L., c.
Scrophularia marylandica L., c.

104. LENTIBULARIACEAE.

Utricularia vulgaris L l.

105. ORABANCHACEAE.

Conopholis americana Wallr., l.
Leptamnium virginianum Raf., c.

106. BIGNONIACEAE.

Catalpa catalpa Karst, not r.
Tecoma radicans DC., c.

107. ACANTHACEAE.

Ruellia strepens L., c.
Dianthera americana L., c.

108. PHRYMACEAE.

Phryma leptostachya L., c.

109. PLANTAGINACEAE.

Plantago aristata Michx., l., r.
  cordata Lam., l.
  lanceolata L., c.
Plantago major L., c.
  Rugelii Dec., l.

110. RUBIACEAE.

Cephalanthus occidentalis L., c.
Galium aparine L., c.
circaezans Michx., c.
concinnum Torr & Gray, c.
tinctorium L., locally c.
Galium trifidum L., l.
triflorum Michx., c.
triflorum luteum Wetzstein, s.
triflorum purpureum Wetz., s.

111. CAPRIFOLIACEAE.

Lonicera caprifolium L., s.
dioica L., l.
glaucescens Rydb., not c.
japonica Thunb., escaped.
sempervirens L., s.
tartarica L., s.
Sambucus canadensis L., c.
Symphoricarpus racemosus Michx., l.
Triosteum perfoliatum L., c.
Viburnum acerifolium L., l.
dentatum L., not c.
opulus L., s.
prunifolium L., c.
pubescens Pursh., l.

112. VALERIANACEAE

Valeriana pauciflora Michx., l.
Valerianella radiata Dufr., c.

113. DIPSACACEAE.

Dipsacus sylvestris Huds. c.

114. CUCURBITACEAE.

Citrullus vulgaris Schrad., escaped
Micrampelis lobata Greene, c.
Sicyos angulatus L., l.

115. CAMPANULACEAE.

Campanula americana L., c.
rapunculoides L., one place at N. W. end of St. Marys. O
Lobelia cardinalis L., l.
inflata L., l.
syphilitica L., c.

116. CICHORIACEAE.

Adopogon virginicum Kuntze, l.
Cichorium intybus L., c.
intybus divaricatum D C., s.
Hieracium scabrum Michx., l.
Lactuca canadensis L., c.
floridana Gaertn., l.
sagittifolia Ell., c.
villosa Jacq., l.
scariola L., c.
Nabalus altissimus Hook, c.
Sonchus asper All., c.
oleraceus L., c.
arvensis L., s.
Taraxacum taraxacum Karst., c.
erythrospermum., l.
Tragopogon porrifolius L., l.
pratensis L., s.

117. AMBROSIACEAE.

Ambrosia artemisiaefolia L., c.
trifida L., c.
trifida integrifolia T. & G., l.
Xanthium canadense Mill, c.

118. COMPOSITAE.

Achillea miliefolium L., very c.
Antennaria neodioica Greene, l.
plantaginifolia Richards. l.
Anthemis cotula L., very c.
Arctium minus Schk., c.
Artemisia annua L., locally c.
biennis Willd., l.
Aster cordifolus L., c.
cordifolius alveariusBurgess. l.
cordifolius candidus Wetz., r.
Drummondii Lindl., not c.
hirsuticaulis Lindl., l.
laevis L., r.
lowrieanus Porter, c.
lowrieanus lancifolius Porter, with type.
multiflorus Ait., l.
Novae-Angliae L., c.
Novae-Angliae candidus Wetzstein, s.
Novae-Angliae roseus Wetzstein, s.
paniculatus acutidens Burgess, l.
paniculatus bellidiflorus Burgess, l.
paniculatus simplex Burgess.c
puniceus L., locally c.
puniceus lucidulus A. Gray, l.
salicifolius Lam., l.
Tradescanti L., c.
Tradescanti X lateriflorus Wetzstein, 1 specimen.
ericoides pilosus Porter, l., r.
ericoides platyphyllusT.&G., r.
Bidens cernua L., locally c.

comosa Wiegand, c.
connata Muhl., l.
connata involucrata Wetzst., a few specimens.
frondosa L., c.
trichosperma Britton, c.
trichosperma tenuiloba Britton, on an island in reservoir.
Boltonia asteroides L'Her., localy-c
Carduus altissimus L., l.
arvensis Robs., l. not c.
discolor Nutt, not r.
lanceolatus L., l.
muticus Pers., l.
Centaurea cyanus L., s.
Chrysanthemum leucanthemum L., c.
parthenium Pers., s.
Coreopsis tinctoria Nutt. sporadically escaped.
Doellingeria umbellata Nees, r.
Eclipta alba Haussk., c.
Erechtites hieracifolia Raf., c. locally.
Erigeron annuus Pers., c.
philadelphicus L., c.
ramosus B. S. P., l.
Eupatorium ageratoides L. f., c.
maculatum L., l.
perfoliatum L., c.
perfoliatum truncatum A. Gray, s.
purpureum L., l.
Euthamia graminifolia Nutt, c.
Gnaphalium obtusifolium L., l.
purpureum L., l.
Helenium autumnale L., l.
Helianthus annuus L., s.
decapetalus L., c.
divaricatus L., l.
doronicoides Lam., not c.
grosse-serratus Martens, c.
laetiflorus Pers., local not c.
tuberosus L., l.
Heliopsis heleanthoides B. S. P., c.
scabra Dunal, l.
Inula helenium L., l.
Leptilon canadense Britton, very c.
Polymnia canadensis L., l.
Ratibida pinnata Barnhart, locally c.
Rudbeckia hirta L., l.
laciniata L., locally c.
triloba L., c.
triloba indivisa Wetzstein, s.
Senecio aureus L., c.
obovatus Muhl., l.
Silphium perfoliatum L., c.
Solidago caesia L., c.
caesia axillaris A. Gray, l.
canadensis L., c.
canadensis procera T. & G., l.
canadensis scabriuscula Porter, l.
flexicaulis L., l.
juncea Ait., local, not c.
rigida L., abundant, east bank of Reservoir.
ulmifolia Muhl., locally c.
Tanacetum vulgare L., l.
Verbesina alternifolia Britton, l.
Vernonia fasciculata Michx., c.

Proceedings

of the

Ohio State

Academy of Science

VOLUME IV, PART 9

Fifteenth Annual Report

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume IV, Part 9

Fifteenth Annual Report

of the

Ohio State Academy of Science 1906

Organized 1891 Incorporated 1892

Publication Committee

J. H. Schaffner J. C. Hambleton E. L. Rice

Date of Publication, April 25, 1907

Published by the Academy
Columbus, Ohio

Officers — 1907

PRESIDENT.

CHARLES DURY.

VICE-PRESIDENTS.

W. F. MERCER, FRANK CARNEY

SECRETARY.

L. B. WALTON.

TREASURER.

JAS. S. HINE.

LIBRARIAN.

W. C. MILLS.

EXECUTIVE COMMITTEE.

Ex-Officio.

CHARLES DURY, JAS. S. HINE, L. B. WALTON.

Elective.

F. C. WAITE, A. D. COLE.

BOARD OF TRUSTEES

W. R. Lazenby, Chairman, term experies........................ 1909
C. J. Herrick, term expires.. 1907
G. B. Halsted, term expires.. 1908

PUBLICATION COMMITTEE.

J. H. Schaffner, Chairman, term expires........................ 1908
E. L. Rice, term expires.. 1907
J. C. Hambleton, term expires..................................... 1909

Past Officers

PRESIDENTS.

1892.	E. W. Claypole,	1899.	G. F. Wright,
1893.	Edward Orton,	1900.	Josua Lindahl,
1894.	F. M. Webster,	1901.	A. D. Selby,
1895.	D. S. Kellicott,	1902.	W. R. Lazenby,
1896.	A. A. Wright,	1903.	C. J. Herrick,
1897.	W. A. Kellerman,	1904.	E. L. Moseley,
1898.	W. G. Tight,	1905.	Herbert Osborn,

1906. E. L. Rice.

VICE-PRESIDENTS.

1892. A. A. Wright, Ellen E. Smith.
1893. D. S. Kellicott, D. L. James.
1894. G. H. Colton, Mrs. W. A. Kellerman.
1895. H. E. Chapin, Jane F. Winn.
1896. A. L. Treadwell, Charles Dury.
1897. C. E. Slocum, J. B. Wright.
1898. Josua Lindhal, J. H. Todd.
1899. Chas. E. Albright, A. D. Selby.
1900. J. A. Bownocker, Lynds Jones.
1901. H. Herzer, Mrs. W. A. Kellerman.
1902. C. J. Herrick, C. S. Prosser.
1903. J. A. Bownocker, Miss L. C. Riddle.
1904. Lynds Jones, L. H. McFadden.
1905. C. W. Dabney, F. M. Comstock.
1906. Charles Dury, Lynds Jones.

TREASURERS.

1892–95.	A. D. Selby,	1899–04.	Herbert Osborn,
1896–98.	D. S. Kellicott,	1905.	Jas. S. Hine.

SECRETARIES.

1892.	W. R. Lazenby,	1895–03.	E. L. Moseley,
1893–94.	W. G. Tight,	1904.	F. L. Landacre,

1905. L. B. Walton.

TRUSTEES.

1900–04.	F. M. Webster,	1900–05.	J. H. Schaffner,
1900–02.	H. C. Beardslee,	1901–06.	W. R. Lazenby,
1904–06.	C. J. Herrick,	1905–06.	G. B. Halsted.

PUBLICATION COMMITTEE.

1892–01.	F. M. Webster,	1900–06.	J. H. Schaffner,
1892–97.	W. A. Kellerman,	1901–03.	L. H. McFadden,
1892–96.	E. W. Claypole,	1902–04.	Gerard Fowke,
1897–99.	E. L. Moseley,	1904–05.	Jas. S. Hine,
1898–00.	S. Belle Craver,	1905–06.	E. L. Rice,

1906. J. C. Hambleton.

Membership

MAY 1, 1907.

Life Member

McMillen, Emerson E. ....320 Riverside Drive, New York, N. Y.

Active Members

Adams, Chas. C. ....Cin. Society of Natural History, Cincinnati
Aiken, W. H. ....Station K, Cincinnati..
Albright, Charles E. ....Columbus
Armstrong, C. A., *Geology* ....Canton
Ball, E. D., *Entomology* ....Logan, Utah
Ballard, C. McE., *Biology* ....Gambier
Baird, R. L., *Zoology, Geology* ....Denmark, Iowa
Benedict, S. M. ....Yale University, New Haven, Conn.
Berger, E. W., *Zoology* ....Gainesville, Florida
Bing, S. H., *Botany, Zoology* ....Bidwell
Black, J. G. ....Wooster
Blackman, M. W. ....Western Reserve Medical College, Cleveland
Blair, Kate R. ....1501 Neil Ave., Columbus
Bolin, W. C., *Engineering* ....R. D. No. 1, Newark
Bonser, T. A., *Botany, Geology* ....02217 Monore St., Spokane, Wash.
Bownocker, John A., *Geology* ....O. S. U., Columbus
Box, Cora May, *Zoology* ....Univ. of Cincin., Cincinnati
Braam, Maximilian, *Biology* ....3114 Vine St., Cincinnati
Branson, E. B. ....Oberlin
Breese, B. B., *Psychology* ....Univ. of Cincin., Cincinnati
Brockett, Ruth E., *Botany* ....Rio Grande
Brookover, Chas. ....Buchtel College, Akron
Brugger, Harvey, *Botany* ....Fremont
Bubna, Matthias, *Entomology* ....2969 Woodhill Road, Cleveland
Burgess, A. F., *Entomology* ....20 John St., Boston, Mass.
Carney, Frank, *Geology* ....Granville
Carter, Chas., *Entomology* ....State Normal School, Albion, Idaho
Claassen, Edo, *Botany* ....18 Fernwood Ave., East Cleveland
Clevenger, J. F., *Botany* ....Wheaton College, Wheaton, Ill.
Coberly, E. D., *Meteorology, Botany* ....Weather Bureau, Reno, Nev.

COLE, A. D., *Physics*..............................O. S. U., Columbus
COLTON, GEORGE H..Hiram
COMSTOCK, FRANK M., *Vert. Zoology*...........Case School, Cleveland
COOVER, A. B., *Archaeology*.........................O. S. U., Columbus
COTTON, E. C., *Entomology*............Experiment Sta, Knoxville, Tenn.
COPELAND, W. F.........................Clark Univ., Worcester, Mass.
DABNEY, CHAS. W.........................Univ. of Cincin., Cincinnati
DARLING, CHESTER A..............475 Manhattan Ave., New York, N. Y.
DAVIS, V. H., *Horticulture*.........................O. S. U., Columbus
DETMERS, FREDA, *Botany*......................1315 Neil Ave., Columbus
DUNLAP, FRED, *Forestry*..........U. S. Forest Service, Washington, D. C.
DURRANT, E. P..Westerville
DURY, CHAS ....537 Ridgway Ave., Cincinnati
DUTTON, C. F., JR.........................64 W. Roy Ave., Cleveland
EDWARDS, E. H., *Zoology, Physiology*..........259 Clinton St., Cleveland
FEIEL, ADOLPH...............................520 E. Main St., Columbus
FIELD, IRVING A., *Biology*............................Westminster, Md.
FINK, BRUCE, *Botany*...Oxford
FISCHER, WALTER, *Botany*..............U. S. Dept. of Agr., Bureau
of Plant Industry, Washington, D. C.
FISCHBACH, H. P., *Biology*..................................Newport, Ky.
FLETCHER, M. S...........................7th St. near Vine, Cincinnati
FLYNN, MAUD, *Zoology*.....................338 W. 6th Ave., Columbus
FOLTZ, H. L., *Biology*..............................Box 264, Gambier
FOOTE, E. H., *Biology*......................................Granville
FOWKE, GERARD, *Glacial Geology, Archaeology*.........105 N. 2d St.,
St. Louis, Mo.
FRANK, J. N. *Botany, Entomológy*...................O. S. U., Columbus
FULLMER, E. L., *Botany*..Berea
GARY, L. B., *Geology*................251 Northampton St., Buffalo, N. Y.
GIBBS, DAVID ....Milan
GREGORY, W. M..............................116 Olive St., Cleveland
GROVER, F. O., *Botany*.......................................Oberlin
GRIGGS, R. F., *Botany*.....................1318 Forsythe Ave., Columbus
GUYER, M. F..........................Univ. of Cincinnati, Cincinnati
HALSTED, G. B., *Mathematics*.................Box 68, Greeley, Colorado
HAMBLETON, J. C., *Botany, Zoology*...........212 E. 11th Ave., Columbus
HANSEN, HERMINA J., *Biology*..........Hughes High School, Cincinnati
HARTZELL, J. C................Univ. of the Pacific, San Jose, California
HARVEY, RUTH S., *Ornithology*...........................Bond Hill
HARVEY, GERTRUDE F., *Ornithology*...........................Bond Hill
HAWK, J. F., *Biology*...Athens
HAWKINS, L. A., *Botany*.....Bureau of Plant Ind., Washington, D. C.
HAYES, SETH ....Dayton

HEILMAN, WM. T. .... Canal Winchester
HERMS, W. B. .... Columbus
HERRICK, C. JUDSON .... Granville
HERZER, H., *Paleontology* .... Marietta
HILLIG, FRED J. .... St. John's College, Toledo
HINE, J. S., *Entomology, Ornithology* .... O. S. U. Columbus
HIXSON, A. H., *Zoology* .... Ada
HOBBS, P. L., *Chemistry* .... Western Reserve Med. College, Cleveland
HOKE, GEO. W., *Geography, Biology* .... Oxford
HOLT, W. P., *Botany* .... 1004 Jefferson Ave., Toledo
HOUK, ELIZA P. T., *Chemistry* .... Dayton
HOUSER, J. S., *Entomology* .... Wooster
HUBBARD, G. D., *Geology, Physiography* .... O. S. U., Columbus
HYDE, J. E., *Geology* .... Lancaster
JACKSON, C. F., *Zoology* .... O. S. U., Columbus
JAMES, C. B. .... Adelbert College, Cleveland
JAMES, DAVIS L. .... 127 W. Seventh St., Cincinnati
JANNEY, JOHN J., *Horticulture* .... 93 Fifteenth Ave., Columbus
JENNINGS, O. E., *Botany* .... Carnegie Museum Annex, Pittsburg, Pa.
JONES, LYNDS, *Ornithology* .... College Museum, Oberlin
JONES, ROBT. RALSTON, *Geology* .... U. S. Engineer's Office, Cincinnati
JUDSON, C. A., *Botany* .... 235 Columbus Ave., Sandusky
KEELER, MISS H. L., *Botany* .... 93 Olive St., Cleveland
KELLERMAN, WILLIAM A., *Botany* .... 175 W. Eleventh Ave., Columbus
KELLERMAN, MRS. W. A., *Botany* .... 175 W. Eleventh Ave., Columbus
KIEFER,, R. J. .... Upper Sandusky
KOCK, H. E., *Zoology, Physics* .... 3148 Jefferson Ave., Cincinnati
LANDACRE, F. L., *Zoology* .... O. S. U., Columbus
LAZENBY, WM. R., *Horticulture, Botany* .... O. S. U., Columbus
LEE, MARY E., *Geology* .... Westerville
LINDAHL, JOSUA, *Zoology* .... Station E., Cincinnati
LLOYD, JOHN URI .... Court and Plum Sts., Cincinnati
MALLY, C. W., *Entomology* .... Dept. of Agriculture, Columbus
MARTZOLFF, C. L., *Archaeology* .... New Lexington
MASTERMAN, E. E., *Zoology, Botany* .... New London
MATHENY, W. A. .... Sardis
MATHEWS, MARY E. .... Painesville
MCCALL, A. G., *Agronomy* .... O. S. U., Columbus
MCCAMPBELL, EUGENE F., *Bacteriology* .... O. S. U., Columbus
MCCAUGHEY, VAUGHAN, *Biology* .... 475 Manhattan av, New York, N. Y.
MCCONNELL, HARRY B., *Ornithology* .... Cadiz
MCCOY, C. T., *Botany* .... 317 E. Mulberry St., Lancaster
MCDANIEL, J. E., *Biology* .... Athens
MCELHINNEY, FRANK B., *Botany* .... New London

McFadden, L. H., *Chemistry*..............................Westerville
McKean, T. L., *Botany*....................................Berea
Mead, Chas. S., *Zoology, Botany*.............217 King Ave., Columbus
Mercer, W. F., *Biology*......................Ohio University, Athens
Metcalf, Zeno P...Plympton
Mills, W. C., *Archaeology, Biology*.................O. S. U., Columbus
Morse, Max W., *Zoology*...............600 W. 125th St., New York City
Morse, W. C., *Biology, Geology*.....................O. S. U., Columbus
Morris, C. H., *Ornithology*............................McConnelsville
Moseley, E. L., *Zoology, Botany, Physiography*...............Sandusky
Nelson, James A., *Zoology, Embryology*...................Ithaca, N. Y.
Newell, Wilmon, *Entomology*.......................Baton Rouge, La.
Oberholser, H. C...........1349 Harvard St., N. W., Washington, D. C.
Odenbach, F. L., *Meteorology*...........St. Ignatius College, Cleveland
Osborn, Herbert, *Entomology, Zoology*.............O. S. U., Columbus
Osburn, Raymond C., *Zoology, Ichthiology*..510 W. 124th St., New York
Outhwaite, Joseph H..Columbus
Oviatt, H. L., *General Science*................................Norwalk
Pallister, H. D.......................Terlingua, Brewster Co., Texas
Peppel, S. V., *Chemistry*.....................1538 N. High St., Columbus
Pickel, Geo. J., *Chemistry*...............St. Ignatius College, Cleveland
Piwonka, Thomas..........................243 Superior St., Cleveland
Porterfield, J. C..................916 New Hayden Building, Columbus
Prosser, C. S., *Geology*............................O. S. U., Columbus
Pumphrey, J. Homer, *Ornithology*..............................Clayton
Rice, Edward L., *Zoology*....................................Delaware
Roudebush, Lowell, ...Owensville
Royer, John S., *Biology*.......................247 N. 17th St., Columbus
Sanders, J. G., *Entomology, Botany*......................................
............Bureau of Entomology Dept. Agr., Washington, D. C.
Sanders, A. E..............................420 Church St., Chillicothe
Sanger, U. G., *Botany*..Newark
Sauer, Lewis W., *Botany*...............Univ. of Cincinnati, Cincinnati
Schaffner, J. H., *Botany*..........................O. S. U., Columbus
Seaton, Miss F.......................103 Glen Park Place, Cleveland
Selby, A. D., *Botany*.......................Experiment Sta., Wooster
Slocum, C. E...Defiance
Smead, Anna, *Biology*.........................634 Nestle St., Toledo
Smith, Ethel M...............................134 Station St., Ashtabula
Smith, G. D., *Botany, Zoology*.....................450 Spicer St., Akron
Smith, J. Warren, *Meteorology*............Weather Bureau, Columbus
Smyth, Lumina C. Riddle, *Botany*.....1211 W. 16th St., Topeka, Kans.
Snyder, F. D., *Zoology, Ethnology*...........................Ashtabula
Soule, William ....1804 S. Union Ave., Alliance

Stair, L. D. . . . . .92 Wadena St., Cleveland
Stauffer, Clinton R., *Geology* . . . . .390 King Ave., Columbus
Sterki, Victor, *Conchology, Botany* .New Philadelphia
Stickney, M. E., *Botany* . . . . .Granville
Stockberger, W. W., *Botany* . . . . . .Dept. Agriculture, Washington, D. C.
Stoner, Minnie A., *Domestic Science* . . . . .O. S. U., Columbus
Surface, F. M., *Zoology, Botany* . . . . .Eaton
Sweezey, Otto H. .1019 Olaho Lane, Honolulu, Hawaii
Taylor, Albert . . . . .Bedford
Thompson, Mrs. King . . . . .167 W. Tenth Ave., Columbus
Tillman, Miss Opal I., *Botany* . . . . .Tucson, Arizona
Tight, W. G., *Geology* . . . . .Albuquerque, N. M.
Todd, Joseph H., *Geology, Archaeology* . . . . .Christmas Knoll, Wooster
Todd, Otto K. . . . . .Vermillion
True, H. L. . . . . .McConnelsville
Tyler, F. J., *Botany* . . . . . .Bureau of Plant Industry, Washington, D. C.
Tyler, Harriet Burr, *Botany* . .
. .Bureau of Plant Industry, Washington, D. C.
Van Hook, J. M., *Plant Pathology* . . . . .Experiment Station, Wooster
Waite, F. C. . . . . .Western Reserve University, Cleveland
Walton, L. B., *Biology* . . . . .Gambier
Webb, R. J., *Botany* . . . . .Garrettsville
Webster, F. M., *Entomology* . .U. S. Dept. Agriculture, Washington, D. C.
Wells, Jessie, *Botany* . . . . .McConnelsville
Werthner, William, *Botany* . . . . .Steele High School, Dayton
Westgate, Lewis G., *Geology* . . . . .Delaware
Wetzstein, A., *Botany* . . . . .309 W. 141st St. ,New York, N. Y.
Whitney, W. C., *Biology, Geology* . . . . .Westerville
Wieman, Harry L., *Biology* . . . . .Univ. of Cincinnati, Cincinnati
Williams, Stephen R., *Biology* . . . . .Miami University, Oxford
Williamson, E. Bruce, *Ichthiology, Ornithology* . . . . .Bluffton, Ind.
Wolfe, E. E., *Botany* . . . . .Marietta College, Marietta
Wright, G. Frederick, *Geology* . . . . .Oberlin
Yanney, Lula Hock . . . . .Alliance
York, Harlan H., *Botany* . . . . .Univ. of Texas, Austin, Texas
Young, R. A., *Botany* . .
. .Div. Seed and Plant Introduction Washington, D. C.

Report of the Fifteenth Annual Meeting

of the

Ohio State Academy of Science

ANNUAL MEETING

The sixteenth annual meeting of the Academy was held in Columbus on November 29 and 30, and December 1, 1906, the First Vice President of the Society, Mr. Charles Dury, of Cincinnati, presiding, owing to the unavoidable absence of Prof. E. L. Rice, the President.

On Thursday evening an informal reception was held at the residence of Prof. and Mrs. Herbert Osborn, 485 King avenue.

Thursday morning at 9:45 the meeting was called to order by the Vice President in room 46 of Physics Hall, of the State University. A committee on membership consisting of Prof. Hine, Prof. Lynds Jones and the secretary, together with a committee on resolutions consisting of Prof. Guyer, Prof. Stickney, and Prof. Waite, was appointed by the chair. The report of the secretary was presented and accepted. The report of the treasurer, Prof. J. S. Hine, was presented and after reference to an auditing committee consisting of Messrs. Burgess and Adams was accepted. The following is a brief summary:

Report of the Treasurer for the Year 1906.

For the year since our last annual meeting the receipts, including balance from last year, have amounted to $209.05, and the expenditures to $207.75, leaving a cash balance of $1.30.

RECEIPTS.

Balance from last year	$0 47	
Membership dues	188 00	
From sale of publications	20 58	
Total		$209 05

DISBURSEMENTS.

For printing the annual report................	$60 00
183 subscriptions to the Ohio Naturalist.....	91 50
Miscellaneous	56 25
Balance December 1, 1906.....................	1 30
Total	$209 05

Respectfully submitted,
JAMES S. HINE.

Prof. Lazenby, chairman of the trustees, presented the following report, which was approved and accepted. Mention was made of the continued interest in the Society manifested by Mr. Emerson McMillin in his gift of $250.

REPORT OF THE BOARD OF TRUSTEES.

The annual appropriations from the "Emerson McMillin Research Fund" have been continued the past year, and the total amount assigned for research has been somewhat larger than usual.

The Board of Trustees feel that excellent work has been done by the Academy through the aid of this fund, and express the hope that this work will be continued with unabated energy and enthusiasm until the "Natural History of Ohio" is more complete and up-to-date than that of any other state.

We again have the satisfaction of acknowledging the contribution of $250 by Mr. Emerson McMillin for the year 1907. We present the following financial statement for the past year.

WILLIAM R. LAZENBY,
C. J. HERRICK.

FINANCIAL STATEMENT OF THE EMERSON McMILLIN RESEARCH FUND, OHIO ACADEMY OF SCIENCE.

1905–1906.

RECEIPTS.

1905.	Balance on hand Nov. 20, 1905......................	$216 48
	Check from Emerson McMillin, Nov. 26, 1905.........	250 00
		$466 48

EXPENDITURES.

1906.			
Mar.	13.	Spahr & Glenn, printing 500 copies "Willows of Ohio"	$67 00
Sept.	20.	Dr. V. Sterki, research work on Ohio Mollusca	11 45
	24.	Prof. W. B. Herms, research work in Zoology	40 00
	25.	Jesse E. Hyde, research work in Geology	21 40
Oct.	8.	Prof. F. Carney, research work in Geology	40 00
	8.	Dr. V. Sterki, research work on Ohio Mollusca	15 75
Nov.	3.	Dr. V. Sterki, research, Mollusca	10 05
	19.	Prof. Chas. Brookover, special study of neurenes in dog-fish	35 00
			$240 75

Balance on hand, $225.73.

Of this balance $53.60 have been appropriated, but not expended, leaving unappropriated balance of $170.13.

William R. Lazenby,
for Trustees.

Nov. 30, 1906. We have examined this report and have found it correct.

A. F. Burgess,
Chas. C. Adams,
Auditing Committee.

The report of the publication committee was presented, approved and accepted.

Prof. Osborn, chairman of the committee on the Natural History Survey, presented a report. It was moved and seconded that the report be accepted, the committee be enlarged, and that an appropriation not to exceed $50 be made to meet the expenses incurred by the committee in the efforts to establish the survey. The librarian presented a report which was approved and accepted.

LIBRARIAN'S REPORT.

I herewith take pleasure in presenting to the Treasurer of the Ohio State Academy of Science my report upon the sales of the publications of the Academy:

Amount on hand November 29th, 1905	$2 27
Cash received from Annual Reports and Special Papers	18 09
Total	$20 36

REPORT OF EXPENDITURES FOR THE YEAR 1906.

Paid out for postage on letters and publications sold	$1 59
For express	30
For postage on Special Paper No. 11	6 36
Postage on Fourteenth Annual Report	4 38
Large envelopes for sending out reports and printing	3 75
Money turned over to the Treasurer	4 20
Total expenditures and cash paid Treasurer	$20 58

WM. C. MILLS.

The report of the committee on the revision of the constitution was presented. Moved and seconded that the report be accepted, the committee be enlarged by the addition of the executive committee, and continued, and that a revision of the constitution and by-laws be printed and submitted to members of the society for approval at the next annual meeting. It was the sense of the meeting that the preliminary revision be published in the Ohio Naturalist. At the request of the chairman of the committee on libraries, the report was deferred to the last business meeting.

After an address of welcome from the chairman of the local committee, the Society proceeded to the reading of papers.

At 12:05 P. M. the Society adjourned to a luncheon provided by the University.

The Society met at 1:30 P. M. and listened to an interesting address by Mr. Dury, First Vice President, on the Natural History of the lower Rio Grande. After an election of a nominating committee consisting of Prof. Osborn, Prof. Landacre and the secretary, the Society again proceeded to the reading of the special papers, and adjourned at 5:30 P. M.

At 7:30 P. M. the members of the Society and their friends listened to an address by Prof. J. A. Bownocker on "Earthquake and Volcanic Phenomena." This was followed by an informal reception.

The Society reassembled at 9:20 Saturday morning. The nominating committee reported and the following officers were elected for the coming year:

President — Mr. Charles Dury, Cincinnati, Ohio.
Vice-Presidents — Prof. W. F. Mercer, Athens, Ohio, and Prof. Frank Carney, Granville, Ohio.
Secretary — Professor L. B. Walton, Gambier, Ohio.
Treasurer — Professor J. S. Hine, Columbus, Ohio.
Librarian — Professor W. C. Mills, Columbus, Ohio.
Executive Committee (ex-officio) Mr. Charles Dury, Cincinnati; Prof. L. B. Walton, Gambier; Prof. J. S. Hine, Columbus, (elective); Prof. F. C. Waite, Cleveland;; Prof. A. D. Cole, Columbus.
Board of Trustees — Professor W. R. Lazenby (re-elected).
Publication Committee — Professor J. C. Hambleton.

The membership committee reported on the following, who were duly elected:

Hawkins, L. A., Botany, O. S. U., Columbus, Ohio.
Sanders, E. A., Botany, Geology Chillicothe Ohio.
Hawk J. F. Biology, Athens, Ohio.
Foltz, H. L., Biology, Gambier, Ohio.
Foote, E. H., Biology, Granville.
Bolin, W. C., Newark.

The following names were elected by the Executive Committee during the year:

Darling, C. A., Zoology and Botany........Portland, Chaut. Co., N. Y.
Wells, Jessie, Botany....................................McConnelsville
Houser, J. S., Entomology.................Ohio Exp. Station, Wooster
Pumphrey, J. H., Ornithology..................................Clayton
McCaughey, Vaughan, Biology and Geology..Cornell Univ., Ithaca, N. Y.
Box, Cora May, Zoology (Protozoa in particular)................ ....University of Cincinnati, Cincinnati
Smith, Ethel M., Biology, (Ornithology in particular),............ ....Rame, Ashtabula Co.
Gilbert, Harriet A., Biology, Physiography and Physiology.....Painesville
Smead, Annie E., Biology.........................634 Nessle St., Toledo
Morris, C. H., Biology (Ornithology in particular)......McConnellsville

McCampbell, E. F. . . . . O. S. U., Columbus
McKean, T. L. . . . . Berea
Matheney, W. A. . . . . Sardis
Young, R. A. . . . . O. S. U., Columbus
Porterfield, J. C. . . . . Columbus, Ohio
Adams, C. C., Ecology. . . . . . Cincinnati Society, Nat. Hist., Cincinnati, O.
Sauer, L. W., Botany. . . . . Univ. of Cincinnati Cincinnati, O.
McCall, A. G., Horticulture. . . . . O. S. U., Columbus, O.
Morse, W. C. Geology, Zoology, and Botany. . 1950 High St., Columbus, O.
Fink, Bruce, Botany. . . . . Oxford, O.

Under new business it was moved and seconded that the dues be increased from $1.00 to $1.50 a year. This was referred to the Executive Committee. It was moved and seconded that the By-Laws be amended to the effect that the dues of the Librarian be omitted. Carried. It was further moved and seconded that it be the sense of the Academy that no formal session be held at the Christmas meeting of the Allied Educational Associations. Carrid.

The following resolutions were passed:

Be it Resolved, That we, the members of the Ohio State Academy of Science extend our heartiest thanks to the authorities and staff of the Ohio State University for their numerous courtesies in connection with the Sixteenth Annual Meeting of the Academy, and we that further signify our appreciation to Professors Osborn and Cole individually of their special favors to the Academy.

Be it Further Resolved, That we express our sense of obligation to Representative C. V. Trott for his efforts in behalf of the interests of the Academy.

Furthermore, be it Resolved, That we signify to Mr. Emerson McMillin our great appreciation of his continued interest in the efforts of the Academy and for his substantial contributions to the suppor of the projects of the same, and that we extend to him our sincere thanks for his numerous favors.

M. F. Guyer, *Chairman.*
F. C. Waite,
M. E. Stickney.

After this the Academy adjourned.

The complete program of the meeting was as follows:

1 A study of *Pilacre petersii* B. & C. 5 min. — R. A. Young
2 A Preliminary List of the Land and Fresh water Mollusca of Ohio. 5 min. — V. Sterki
3 Better Results in Science Photography. 10 min. — G. D. Smith
4 Notes on a Sandusky Bay Shrimp *Palæmonetes exilipes*. 12 min. — W. B. Herms
5 Platycnemic Man in Ashtabula Co. 5 min. — F. D. Snyder
6 Cell Division in *Euglena oxyuris* Schmarda. 5 min. — L. B. Walton
7 A small agaric with a disputed name. 6 min. — W. A. Kellerman
8 Occurrence of Rare Birds in Ohio in 19066. 5 min. — Lynds Jones
9 Some Physical Properties of Wood. 10 min. — W. R. Lazenby
10 Ohio Archæological Atlas. 5 min. — W. C. Mills
11 On the Occurrence of *Phytophthora infestans* and *Plasmopara cubensis* in Ohio. 8 min. — A. D. Selby
12 Experiments to test the difference of Hydrocyanic Acid Gas in the Fumigation of Houses. 8 min. — A. F. Burgess
13 The Specific Name of Necturus. 8 min. — F. C. Waite

Address by the Vice-President, Chas. Dury: "The Natural History of the Lower Rio Grande."

14 Weather and Crop Yield. 15 min. — J. W. Smith
15 An Ecological Survey of Isle Royale, Lake Superior (Illustrated with lantern slides). 18 min. — C. C. Adams
16 A Successful Mutant of Verbena Without External Isolation. 10 min. — J. H. Schaffner
17 A Lantern Talk on Lichenists. 20 min. — Bruce Fink
18 The Vicissitudes of the Cincinnati Ice Dam. 20 min. — G. F. Wright
19 A Botanist's Second Trip to a Tropical Country (Illustrated with lantern slides.) 20 min. — W. A. Kellerman
20 Notes on Guatemalan Hemiptera with description of a few new species. 10 min. — Herbert Osborn
21 A Spear Point containing a nugget of gold. 3 min. — W. C. Mills
22 "Esperanto," a Universal Language for Science. 8 min. — Ivy Kellerman
23 The Public Drinking Cup. A report on the Species of Bacteria found in ten Examinations. 5 min. — E. F. McCampbell
24 Interesting Foreign Seeds Disseminated in Alfalfa. 5 min. — A. D. Selby

Address: "Earthquake and Volcanic Phenomena," with special reference to the San Francisco earthquake and the volcanoes of the Hawaiian Islands (illustrated with lantern slides.) — J. A. Bownocker.

25 Notes on some Interesting Protoza from Cedar Point. 5 min. — Cora M. Box

26	Juvenile Kelps and the Recapitulation Theory (illustrated with lantern slides) 15 min.	R. F. Griggs
27	An Ecological and Experimental Study of Sarcophagidæ with relation to organic beach debris. 15 min.	W. B. Herms
28	Critical Notes on some Ohio Agarics and Polypores with exhibitions of specimens. 15 min.	J. C. Hambleton
29	Further Observations on the Naididæ of Cedar Point. 5 min.	L. B. Walton
30	*Auerswaldia ohionis* Kellerm. nov. sp. 5 min.	W. A. Kellerman
31	Notes on the Myriapod Polydesmus sp. 3 min.	S. R. Williams
32	The Development of the Sporangium in *Equisetum hyemale* L. 8 min.	L. A. Hawkins
33	A Simple Cultural Method for Procuring Protoza for Class-room Study.5 min.	Lynds Jones
34	The Correllation between the method of distribution of Taste Buds and their Nerve Supply in Amerius.	F. L. Landacre
35	Development of the Pineal Region in Ophidia. 15 min.	J. E. McDaniel
36	Histogenesis of Heart Muscle of Chick. 10 min.	H. L. Wieman
37	On the Dipterous Fauna of Ohio. 5 min.	J. S. Hine
38	Observations on the Habits of *Senotania rubroventris* Mac. 3 min.	Herbert Osborn
39	On the Commissures of the Medulla Oblonganta of Fishes (read by title).	C. J. Herrick
40	Collecting Mollusca in 1906. 5 min.	V. Sterki
41	A Southern Wolfiella indigenous in Central Ohio. 8 min.	W. A. Kellerman
42	Shading of Plants with Colored Cloth. 10 min.	W. R. Lazenby
43	New Species of Ohio Hemiptera. 5 min.	Herbert Osborn
44	Fossil Land and Fresh Water Mollusca (in loess?) found at Defiance, Ohio. 5 min.	V. Sterki
45	Note on a Method of Collecting Scutigerella, Scolopendrella, Japyx, Campodea and other minute forms. 3 min.	L. B. Walton
	Annual Report on the State Herbarium. 4 min.	Freda Detmers
46	Footprints of Prehistoric Man in Perry Co. 10 min.	C.. L. Martzolff
47	The Glacial Dam at Hanover, Ohio (illustrated with lantern slides). 25 min.	Frank Carney
48	Preglacial Erosion in Ohio. 15 min.	G. D. Hubbard
49	Corrosion by Ribers, Glaciers and Waves (illustrated with lantern slides). 10 min.	L. G. Westgate
50	Boundary of the oldest Drift Sheet in Licking county, Ohio. [Slides.] 5 min.	Frank Carrey
51	Harness Mound Explorations. 15 min.	W. C. Mills

52 Glacial Folding of Subjacent Strata near Huron, Ohio. 5 min. — E. B. Branson

53 The Radnor Esker System. [Slides.] 10 min. — L. G. Westgate

54 Aboriginal Manufacture of Bone and Stone Implements. 10 min. — A. B. Coover

55 A Buried Valley along the Rocky Fork east of Gahana, Ohio. [Slides.] 5 min. — G. D. Hubbard

56 Pre-Wisconsin Drift in the Finger Lake Region of New York. [Slides.] 10 min. — Frank Carney

57 A Fauna from the Cleveland Shale of Lorain Co. 5 min. — E. B. Branson

58 The Pottsville Formation of Eastern Licking County. [Slides.] 10 min. — Frank Carney

Gambier, O., March 30, 1907.

L. B. Walton, *Secretary.*

Proceedings

of the

Ohio State Academy of Science

VOLUME V, PART 1

Sixteenth Annual Report

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume V, Part I

Sixteenth Annual Report

of the

Ohio State Academy of Science 1907

Organized 1891 Incorporated 1892

Publication Committee

J. H. Schaffner J. C. Hambleton E. L. Rice

Date of Publication, April 25, 1908

Published by the Academy
Columbus, Ohio

Officers — 1908

PRESIDENT.

FRANK CARNEY.

VICE-PRESIDENTS.

J. H. SCHAFFNER, F. C. WAITE.

SECRETARY.

L. B. WALTON.

TREASURER.

JAS. S. HINE.

LIBRARIAN.

W. C. MILLS.

EXECUTIVE COMMITTEE.

Ex-Officio.

FRANK CARNEY, JAS. S. HINE, L. B. WALTON.

Elective.

BRUCE FINK, LYNDS JONES.

Board of Trustees

W. R. LAZENBY, Chairman, term expires.......................... 1909
CHARLES DURY, term expires.. 1910
G. B. HALSTED, term expires.. 1908

Publication Committee

J. H. SCHAFFNER, Chairman, term expires.......................... 1908
E. L. RICE, term expires.. 1910
J. C. HAMBLETON, term expires...................................... 1909

Past Officers

PRESIDENTS.

1892. E. W. Claypole,
1893. Edward Orton,
1894. F. M. Webster,
1895. D. S. Kellicott,
1896. A. A. Wright,
1897. W. A. Kellerman,
1898. W. G. Tight,
1899. G. F. Wright,
1900. Josua Lindahl,
1901. A. D. Selby,
1902. W. R. Lazenby,
1903. C. J. Herrick,
1904. E. L. Moseley,
1905. Herbert Osborn,
1906. E. L. Rice.
1907. Charles Dury.

VICE-PRESIDENTS.

1892. A. A. Wright, Ellen E. Smith.
1893. D. S. Kellicott, D. L. James.
1894. G. H. Colton, Mrs. W. A. Kellerman.
1895. H. E. Chapin, Jane F. Winn.
1896. A. L. Treadwell, Charles Dury.
1897. C. E. Slocum, J. B. Wright.
1898. Josua Lindhal, J. H. Todd.
1899. Chas. E. Albright, A. D. Selby.
1900. J. A. Bownocker, Lynds Jones.
1901. H. Herzer, Mrs. W. A. Kellerman.
1902. C. J. Herrick, C. S. Prosser.
1903. J. A. Bownocker, Miss L. C. Riddle.
1904. Lynds Jones. L. H. McFadden.
1905. C. W. Dabney, F. M. Comstock.
1906. Charles Dury, Lynds Jones.
1907. W. F. Mercer, Frank Carney.

TREASURERS.

1892-95. A. D. Selby,
1896-98. D. S. Kellicott,
1899-04. Herbert Osborn,
1905. Jas. S. Hine.

SECRETARIES.

1892. W. R. Lazenby,
1893-94. W. G. Tight,
1895-03. E. L. Moseley,
1904. F. L. Landacre,
1905. L. B. Walton.

Membership

MAY 1, 1908.

Life Member

McMillin, Emerson E............320 Riverside Drive, New York, N. Y.

Active Members

Adams, Chas. C......Zoological Building, Univ. of Chicago, Chicago, Ill.
Aiken, W. H....................................Station K, Cincinnati
Albright, Charles E.......................................Columbus
Armstrong, C. A., *Geology*, ...110 Chance Ave., Canton
Bachman, Freda M., *Biology*, ...Oxford
Bales, B. R., *Ornithology, Entomology*, ...151 W. Main St., Circleville
Ball, E. D., *Entomology*..................................Logan, Utah
Ballard, C. McE., *Biology*.........Johns Hopkins Univ., Baltimore, Md.
Banta, A. M., *Biology*.......................................Marietta
Beekman, W. S., *Geol., Mineral., Chemistry*......................
....................Cincinnati Society of Natural History, Cincinnati
Benedict, H. M.,..........................Univ. of Cincinnati, Cincinnati
Benedict, S. M.......................Yale University, New Haven, Conn.
Berger, E. W., *Zoology*...........................Gainesville, Florida
Bing, S. H., *Botany, Zoology*...................................Bidwell
Black, J. G...Wooster
Blackman, M. W..........Western Reserve Medical College, Cleveland
Blair, Kate R.............................1501 Neil Ave., Columbus
Bolin, W. C., *Engineering*.........................R. D. No. 1, Newark
Bonser, T. A., *Botany, Geology*........02217 Monore St., Spokane, Wash.
Bownocker, John A., *Geology*.......................O. S. U., Columbus
Box, Cora May, *Zoology*..................Univ. of Cincinnati, Cincinnati
Braam, Maximilian, *Biology*...........Hughes High School, Cincinnati
Branson, E. B...Oberlin
Breese, B. B., *Psychology*...............Univ. of Cincinnati, Cincinnati
Brockett, Ruth E., *Botany*..................................Rio Grande
Brookover, Chas. ....Buchtel College, Akron
Brugger, Harvey, *Botany*.....................218 N. Wood St., Fremont
Bubna, Matthias, *Entomology*...........2969 Woodhill Road, Cleveland
Burgess, A. F., *Entomology*........U. S. Dept. Ag., Washington, D. C.

BURKE, R. H., *Geology and Geography*..........................Oxford
CARNEY, FRANK, *Geology*..................................Granville
CARTÉR, CHAS., *Entomology*...........State Normal School, Albion, Idaho
CLAASSEN, EDO, *Botany*...............18 Fernwood Ave., East Cleveland
CLEVENGER, J. F., *Botany*.................Wheaton College, Wheaton, Ill.
COBERLY, E. D., *Meteorology, Botany*.....Weather Bureau, Helena, Mont.
COGHILL, GEO. E., *Zoology, Neurology*.......................Granville
COLE, A. D., *Physics*............................Poughkeepsie, N. Y.
COLTON, GEORGE H..Hiram
COMSTOCK, FRANK M., *Vert. Zoology*.............Case School, Cleveland
COOVER, A. B., *Archaeology*..........................O. S. U., Columbus
COTTON, E. C., *Entomology*............Experiment Sta., Knoxville, Tenn.
COPELAND, W. F...Athens
CRAMER, WILLIAM, *Zoology*................273 Southern Ave., Cincinnati
DABNEY, CHAS. W..........................Univ. of Cincinnati, Cincinnati
DARLING, CHESTER A., *Botany*...........Columbia Univ. New York, N. Y.
DACHNOWSKI, ALFRED, *Botany*......................O. S. U., Columbus
DAVIS, V. H., *Horticulture*.........................O. S. U., Columbus
DETMERS, FREDA, *Botany*.............................O. S. U., Columbus
DUNLAP, FRED, *Forestry*...........U. S. Forest Service, Washington, D. C.
DURRANT, E. P..Westerville
DURY, CHAS. ....537 Ridgway Ave., Cincinnati
DUTTON, C. F., JR............................64 W. Roy Ave., Cleveland
EDWARDS, E. H., *Zoology, Physiology*........7317 Clinton Ave., Cleveland
FEIEL, ADOLPH ....520 E. Main St., Columbus
FENNEMAN, U. M., *Geology, Geography*....Univ. of Cincinnati, Cincinnati
FIELD, IRVING A., *Biology*..............................Westminster, Md.
FINK, BRUCE, *Botany, Zoology*.....................................Oxford
FISCHER, WALTER, *Botany*...........U. S. Dept. of Agr., Bureau of Plant Industry, Washington, D. C.
FISCHBACH, H. P., *Biology*................................Newport, Ky.
FLETCHER, M. S. ....11 E. 7th St,, Cincinnati
FLYNN, MAUD, *Zoology*.........................338 W. 6th Ave., Columbus
FOLTZ, H. L. *Biology*...Box 286, Lima
FOOTE, E. H., *Biology*...Granville
FOWKE, GERARD, *Glacial Geology, Archaeology*........105 N. 2d St., St. Louis, Mo.
FRANK, J. N., *Botany, Entomology*.........................Hurley, Va.
FULLMER, E. L., *Botany*...Berea
GARY, L. B., *Geology*...............251 Northampton St., Buffalo, N. Y.
GIBBS, DAVID ....Geneva
GREGORY, W. M.................................116 Olive St., Cleveland
GROVER, F. O., *Botany*..Oberlin
GRIGGS, R. F., *Botany*......................1318 Forsythe Ave., Columbus
GUYER, M. F...............................Univ. of Cincinnati, Cincinnati

Halsted, G. B., *Mathematics*..................Box 68, Greeley, Colorado
Hambleton, J. C., *Botany, Zoology*..........212 E. 11th Ave., Columbus
Hansen, Hermina J., *Biology*...........Hughes High School, Cincinnati
Hartzel, J. C..................Univ. of the Pacific, San Jose, California
Harvey, Ruth S., *Ornithology*............1203 Woodland Ave., Bond Hill
Harvey, Gertrude F., *Ornithology*.......1203 Woodland Ave., Bond Hill
Hawk, J. F., *Biology*........................139 W. High St., Fostoria
Hawkins, L. A., *Botany*........Bureau of Plant Ind., Washington, D. C.
Hayes, Seth ....42 Liberty St., Dayton
Heilman, Wm. T.................................Canal Winchester
Henninger, W. F., *Ornithology, Entomology*................New Bremen
Herms, W. B..............................1599 S. High St., Columbus
Herzer, H., *Paleontology*.................................Marietta
Hillig, Fred J..............................St. John's College, Toledo
Hine, J. S., *Entomology, Ornithology*................O. S. U., Columbus
Hobbs, P. L., *Chemistry*........Western Reserve Med. College, Cleveland
Hoke, Geo. W., *Geography, Biology*............................Oxford
Holt, W. P., *Botany*............................2113 Putnam St., Toledo
Houk, Eliza P. T., *Chemistry*................................Dayton
Houser, J. S., *Entomology*..................Santiago de las Vegas, Cuba
Hubbard, G. D., *Geology, Physiography*.............O. S. U., Columbus
Hyde, J. E., *Geology*.....................................Lancaster
Jackson, C. F., *Zoology*............................O. S. U., Columbus
James, C. B...............................Adelbert College, Cleveland
James, Davis L........................127 W. Seventh St., Cincinnati
Jennings, O. E., *Botany*.........Carnegie Museum Annex, Pittsburg, Pa.
Johnson, A. A., *Biology*...............................Box 582, Athens
Jones, Lynds, *Ornithology*.....................College Museum, Oberlin
Jones, Robt. Ralston, *Geology*........U. S. Engineer's Office, Cincinnati
Judson, C. A., *Botany*.....................235 Columbus Ave., Sandusky
Keeler, Miss H. L., *Botany*.........................93 Olive St., Cleveland
Kellerman, William A., *Botany*...... .175 W. Eleventh Ave., Columbus
Kellerman, Mrs. W. A., *Botany*........175 W. Eleventh Ave., Columbus
Kiefer, R. J...Upper Sandusky
Kock, H. E., *Zoology, Physics*.............3148 Jefferson Ave., Cincinnati
Landacre, F. L., *Zoology*...........................O. S. U., Columbus
Lazenby, Wm. R., *Horticulture, Botany*..............O. S. U. Columbus
Lee, Mary E., *Geology*.................................Westerville
Lindahl, Josua, *Zoology*...................5700 Peoria St., Cincinnati
Lloyd, John Uri.......................Court and Plum Sts., Cincinnati
Mackenzie, Mary D., *Biology*.................................Oxford
Mally, C. W., *Entomology*....................Grayhamstown, S. Africa
March, Cora, *Biology*....................................Wyoming
Martzolff, C. L., *Archaeology*...............................Athens
Masterman, E. E., *Zoology, Botany*.......................New London

MATHENY, W. A. . . . . Athens
MATHER, KIRTLEY F., *Geology* . . . . Granville
MATHEWS, MARY E. . . . . Painesville
MCCALL, A. G., *Agronomy* . . . . O. S. U., Columbus
MCCAMPBELL, EUGENE F., *Bacteriology* . . . . O. S. U., Columbus
MCCAUGHEY, VAUGHAN, *Biology* . . . . 475 Manhattan Ave., New York, N. Y.
MCCONNELL, HARRY B., *Ornithology* . . . . Cadiz
MCCOY, C. T., *Botany* . . . . Lancaster
MCCRAY, ARTHUR H., *Zoology and Entomology* . . . . Duval
MCDANIEL, J. E., *Biology* . . . . La Junta, Colo.
MCELHINNEY, FRANK B., *Botany* . . . . New London
MCFADDEN, L. H., *Chemistry* . . . . 40 Warden St., Dayton
MCKEAN, T. L., *Botany* . . . . Berea
MEAD, CHAS. S., *Zoology, Botany* . . . . 217 King Ave., Columbus
MERCER, W. F., *Biology* . . . . Ohio University, Athens
METCALF, ZENO P. . . . . Agricultural College, Mich.
MILLS, W. C., *Archaeology, Biology* . . . . O. S. U., Columbus
MOODY, A. E. . . . . Flushing
MORGULIS, S., *Zoology* . . . . O. S. U., Columbus
MORSE, W. C., *Biology, Geology* . . . . O. S. U., Columbus
MORRIS, C. H., *Ornithology* . . . . McConnelsville
MOSELEY, E. L., *oology, Botany, Physiography* . . . . Sandusky
NELSON, JAMES A., *Zoology, Embryology* . . . . 210 Mitchell St., Ithaca, N. Y.
NEWELL, WILMON, *Entomology* . . . . Baton Rouge, La.
OBERHOLSER, H. C. . . . . 1445 Girard St., N. W., Washington, D. C.
ODENBACH, F. L., *Meteorology* . . . . St. Ignatius College, Cleveland
OSBORN, HERBERT, *Entomology, Zoology* . . . . O. S. U., Columbus
OSBURN, RAYMOND C., *Zoology, Ichthiology* . . 510 W. 124th St., New York
PALLISTER, H. D. . . . . 3754 Independence Road, Cleveland
PICKEL, GEO. J., *Chemistry* . . . . St. Ignatius College, Cleveland
PIWONKA, THOMAS . . . . 226 Superior Ave., Cleveland
PORTERFIELD, J. C. . . . . 916 New Hayden Building, Columbus
PROSSER, C. S., *Geology* . . . . O. S. U., Columbus
PUMPHREY, J. HOMER, *Ornithology* . . . . Clayton
RICE, EDWARD L., *Zoology* . . . . Delaware
ROUDEBUSH, LOWELL . . . . R. F. D., New Richmond
ROYER, JOHN S., *Biology* . . . . 247 N. 17th St., Columbus
SANDERS, J. G., *Entomology, Botany* . . U. S. Dept. Agr., Washington, D. C.
SANDERS, A. E. . . . . Steele High School, Dayton
SANGER, U. G., *Botany* . . . . Newark
SAUER, LEWIS W., *Botany* . . . . Univ. of Cincinnati Cincinnati
SCHAFFNER, J. H., *Botany* . . . . O. S. U., Columbus
SCHEFFEL, EARL R., *Geology* . . . . Granville
SEATON, MISS F. . . . . 103 Glen Park Place, Cleveland
SELBY, A. D., *Botany* . . . . Experiment Sta., Wooster

Slocum, C. E. .... Defiance
Smead, Anna, *Biology* .... 624 Nestle St., Toledo
Smith, Ethel M. .... 122 Center St., Ashtabula
Smith, G. D., *Botany, Zoology* .... 450 Spicer St., Akron
Smith, J. Warren, *Meteorology* .... Weather Bureau, Columbus
Smyth, Lumina C. Riddle, *Botany* .... State House, Topeka, Kans.
Snyder, F. D., *Zoology, Ethnology* .... Ashtabula
Soule, William .... 1804 S. Union Ave., Alliance
Stair, L. D. .... 92 Wadena St., Cleveland
Stauffer, Clinton R., *Geology* .... 5514 Madison Ave., Chicago, Ill.
Sterki, Victor, *Conchology, Botany* .... New Philadelphia
Stickney, M. E., *Botany* .... Granville
Stockberger, W. W., *Botany* ...... Dept. Agriculture, Washington, D. C.
Stoner, Minnie A., *Domestic Science* .... Laramie, Wyoming
Surface, F. M., *Zoology, Botany* .... Orono, Maine
Sweezey, Otto H. .... 12th Ave., Honolulu, Hawaii
Tilman, Miss Opal I., *Botany* .... Tucson, Arizona
Tight, W. G., *Geology* .... Albuquerque, N. M.
Todd, Joseph H., *Geology, Archaeology* .... Christmas Knoll, Wooster
Todd, Otto K. .... Vermillion
True, H. L. .... McConnelsville
Tyler, F. J., *Botany* .... Bureau of Plant Industry, Washington, D. C.
Van Hook, J. M., *Plant Pathology* .... Experiment Station, Wooster
Waite, F. C. .... Western Reserve University, Cleveland
Walton, L. B., *Biology* .... Gambier
Webb, R. J., *Botany* .... Garrettsville
Webster, F. M., *Entomology* .. U. S. Dept. Agriculture, Washington, D. C.
Wells, Jessie, *Botany* .... McConnelsville
Werthner, William, *Botany* .... Steele High School, Dayton
Westgate, Lewis G., *Geology* .... Delaware
Wetzstein, A., *Botany* .... 748 Pleasant St., Hot Springs, Arkansas
Wieman, Harry L., *Biology* .... Univ. of Cincinnati, Cincinnati
Williams, Stephen R., *Biology* .... Miami University, Oxford
Williamson, E. Bruce, *Ichthiology, Ornithology* .... Bluffton, Ind.
Wittenmyer, J. G., *Zoology* .... Peebles
Wolfe, E. E., *Botany* .... Marietta College, Marietta
Wright, G. Frederick, *Geology* .... Oberlin
Yanney, Lulu Hock .... Alliance
York, Harlan H., *Botany* .... Univ. of Texas, Austin, Texas
Young, R. A., *Botany* ....
.... Div. Seed and Plant Introduction, Washington, D. C.

Report of the Sixteenth Annual Meeting

of the

Ohio Academy of Science

The sixteenth annual meeting of the Academy was held at Miami University, Oxford, O., on November 28, 29 and 30, the President, Mr. Charles Dury, of Cincinnati, presiding. On Thursday evening an informal reception took place in Hepburn Hall where accommodations for members of the Academy were generously provided by the University authorities. The sessions on Friday and Saturday were held in Brice Hall.

The meeting was called to order by the President at 9:30 Friday morning. A committee on membership consisting of Prof. Hine, Prof. Durrant, and Prof. Lazenby, together with a committee on resolutions consisting of Prof. Rice, Prof. Waite and Prof. Guyer, was appointed by the chair. The report of the Secretary was presented and accepted. A suggestion was made by Prof. Lazenby that the special papers published by the Society be noted in connection with the proceedings. The report of the Treasurer, Prof. J. S. Hine, was presented and after reference to an auditing committee consisting of Mrs. Hansen and Prof. Rice, was accepted. The following is the report:

REPORT OF THE TREASURER FOR THE YEAR 1906.

For the year since our last annual meeting the receipts, including balance from last year, have amounted to $157.30, and the expenditures to $156.74, leaving a cash balance of $0.56.

RECEIPTS.

Balance from last year	$1.30
Membership dues	156.00
Total	$157.30

DISBURSEMENTS.

For printing the annual report	$30.00
160 subscriptions to the Ohio Naturalist	80.00
Miscellaneous	36.74
Balance December 1, 1906	.56
Total	$157.30

Respectfully submitted,
JAMES S. HINE.

The Librarian of the Society, Prof. Mills, was unavoidably detained in connection with the state exhibit at the Jamestown Exposition, consequently no report was made at the meeting.

Prof. Lazenby, chairman of the Board of Trustees, presented the following report which was approved and accepted. Mention was made of the continued interest in the welfare of the Society manifested by Mr. Emerson McMillin through his gift of an additional $250.00 to the "Emerson McMillin Research Fund." The report of the trustees is as follows:

REPORT OF THE BOARD OF TRUSTEES.

The financial statement of the Emerson McMillin research fund, for the year 1906-1907, is herewith presented:

RECEIPTS.

1906.	Balance on hand Nov. 20, 1906	$225.73
	Check from Emerson McMillin Nov. 11, 1907	250.00
	Total	$475.73

EXPENDITURES.

1907.		
Oct. 3.	Spahr & Glenn, printing 500 copies "Land and Fresh Water Mollusca of Ohio"	$67.50
Oct. 9.	W. C. Morse, expense for travel in research work in Geology	25.00
Nov. 26.	W. C. Morse, expense for travel in research work in Geology	25.00
	Total	$117.50
	Balance on hand November 28, 1907	$358.23

Of this balance there have been appropriated, during the year, but not yet expended, $50.00 for research and $50.00 for publication, leaving an unappropriated balance for the year 1907-1908, of $258.23.

William R. Lazenby,
Chairman.

Prof. Schaffner, Chairman of the Publication Committee, being absent in Europe, no report was at this time offered.

Prof. Herbert Osborn, Chairman of the committee on the proposed State Natural History Survey, noted the enlargement of the committee in accordance with the recommendations of last year, and the issuing of printed copies of the bill with recommendations for the passage of such a measure from the men prominent in educational and professional lines throughout the state. Members of the Academy signified their hearty support of the bill.

The committee on the revision of the constitution and bylaws consisting of the Secretary, Prof. Rice and Prof. Landacre, acting jointly with the executive committee, reported that considerable progress had been made but that it would be impossible to prepare a final report before the next annual meeting. It was moved, seconded and carried that the committee be continued.

The Committee on Scientific Publications in Ohio Libraries reported that a considerable number of libraries had responded to their request for lists of scientific periodicals and that a final report would be prepared for later publication. It was moved, seconded and carried that the report be adopted and that the final report be referred to the publication committee.

Under the order of new business the following nominating committee was elected: Prof. Mercer, Prof. Osborn and Prof. Rice, to report nominations for officers at the last business meeting.

After the reading of papers, the Society adjourned for luncheon at 11:50 A. M.

The Society met at 1:45 P. M. and listened to an address by the President, Mr. Charles Dury, on "Some Reminiscences of the Cincinnati Zoo." Mr. Dury was for a considerable period prosector to the Society and had brought together a large number of interesting facts. His account of the famous fight between the lion and the donkey well illustrated the unreliability of newspaper reports along lines of natural history. Among other things he stated that at least 75 % of the deaths among the monkeys of the "Zoo" resulted from tuberculosis.

The Society then proceeded with the reading of the papers and adjourned at 5:15 P. M.

At 7:30 P. M. Prof. G. W. Hoke talked to the Society concerning life in Constantinople. This was illustrated by a large series of lantern slides.

The Society reassembled at 8:45 Saturday morning. The report of the nominating committee was received and the following officers were elected for the ensuing year:

President — Professor Frank Carney, Granville, Ohio.
Vice-Presidents — Professor J. H. Schaffner, Columbus, Ohio, and Professor F. C. Waite, Cleveland, Ohio.
Secretary — Professor L. B. Walton, Gambier, Ohio.
Treasurer — Professor J. S. Hine, Columbus, Ohio.
Executive Committtee (*ex-officio*) — Professor Frank Carney, Granville; Professor L. B. Walton, Gambier; Professor J. S. Hine, Columbus; (elective) — Professor Bruce Fink, Oxford; Professor Lynds Jones, Oberlin.
Board of Trustees — Mr. Charles Dury, Cincinnati, Ohio. (In place of retiring trustee).
Publication Committee — Professor E. L. Rice. (In place of retiring member).

L. B. Walton,
Secretary.

The following were elected by the executive committee during the year.

Geo. E. Coghill, Granville, Ohio.
W. S. Beekman, 514 East Pearl Street, Cincinnati, Ohio.
Alfred Dachnowski, O. S. U., Columbus, Ohio.
Sergius Morgulus, O. S. U., Columbus, Ohio.
B. R. Bales, M. D., Circleville, Ohio.
M. S. Fletcher, M. D., 11 East Seventh Street, Cincinnati, Ohio.
Arthur H. McCray, Duvall, Ohio.
W. F. Henninger, New Bremen, Ohio.

Mary D. McKenzie, Oxford, Ohio.
Earl R. Scheffel, Granville, Ohio.
Freda M. Bachman, Oxford, Ohio.
Kirtley F. Mather, Granville, Ohio.
J. G. Wittenmyer, O. S. U., Columbus.

The membership committee appointed by the President at the opening session reported on the following who were duly elected:

N. M. Fenneman, University of Cincinnati, Cincinnati, Ohio.
William Cramer, 273 Southern Ave., Cincinnatti, Ohio.
R. H. Burke, Oxford, Ohio.
A. M. Banta, Marietta, Ohio.
M. E. Kleckner, Tiffin, Ohio.
A. A. Johnson, Athens, Ohio.
Cora March, Wyoming, Ohio.

The committee on resolutions reported as follows:

Be it Resolved, That we, the members of the Ohio State Academy of Science, hereby express our sense of loss in the death, during the past year, of two of our members, Albert Taylor and William Curtis Whitney.

Be it further Resolved, That we signify to Mr. Emerson McMillin our great appreciation of his continued interest in the efforts of the Academy, and for his substantial contributions to the support of the projects of the same, and that we extend to him our sincere thanks for his numerous favors.

Be it further Resolved, That we extend our heartiest thanks to the authorities of Miami University and to the members of the Local Committee for their numerous courtesies in connection with the Sixteenth Annual Meeting of the Academy.

Edward L. Rice,
M. F. Guyer,
F. C. Waite,
Committee.

Since the meeting at Oxford the Secretary has noted the deaths of two other members, The Hon. Joseph H. Outhwaite, and John J. Janney, both residents of Columbus, O., the deaths occurring within a few days of one another. Both have lived long and useful lives and have at various times signified their interest in the affairs of the Academy. Mr. Janney died at the advanced age of 96 years.

A committee consisting of the incoming President, Secretary and Treasurer was appointed to confer with the Indiana Academy of Science concerning the advisability of holding joint meetings periodically, at some locality near the border line of the two states. The opinion was expressed that such meetings would prove of much interest and that it would be an excellent thing for members of the two academies to meet at intervals at least as often as three years.

An invitation was extended by the incoming President of the Society to meet at Granville in November, 1908. While no definite action was taken by the executive committee, the opinion was generally expressed that the invitation would be accepted.

At the close of the business session, the Society proceeded with the reading of papers.

At 11:45 A. M. the Academy was declared formally adjourned.

The complete program of the meeting was as follows:

1 A Study of the Origin and Growth of the Egg in *Syncoryne mirabilis*. 8 min. — Mary D. Mackenzie

2 A Better Method of Preparing Herbarium Specimens. 7 min. — W. A. Kellerman

3 Compensatory Growth in *Podarke obscura*.. 8 min. — Sergius Morgulis

4 Note on the Development of the Skull in Clupea. 10 min. — Edward L. Rice

5 Factors determining Cave Habitation as illustrated by the Cave Isopod and its nearest outdoor ally. 12 min. — A. M. Banta

6 *Symbiotes duryi* n. sp., A New Endomychid from Ohio. 4 min. — L. B. Walton

7 Notes on the Early Development of Enteropnuesta. 8 min. — B. M. Davis

8 The Discomycetes of Oxford and Vicinity. 15 min. — Freda M. Bachman

9 *Wolffia brasilensis* in Ohio. 3 min. — Robert F. Griggs

10 "The Psychology of Speaking," a Scientific Analysis of the Art of Speaking. 10 min. — John S. Royer

12:00. Luncheon.

1:30 p. m. President's Address. Zoological Reminiscences of the Cincinnati "Zoo." — Charles Dury

2:30 p. m. Reading of Papers.

11\. The Flora of Cranberry Island, Buckeye Lake. 7 min. — W. A. Kellerman

12 Reaction of Amphibian Embryos to Tactile Stimuli. 10 min. G. E. Coghill
13 The Epibranchial Placodes of Ameiurus. 9 min. F. L. Landacre
14 Periodicity of Spirogyra. 10 min. W. F. Copeland
15 The Dispersal and Planting of Seeds by Nature's Methods. 15 min. W. R. Lazenby
16 The Male Reproductive Organs of *Cimbex americanus* Leach. H. H. Severin and H. C. Severin
17 A Peculiar Circulatory Modification in *Necturus maclosus*. 6 min. S. R. Williams
18 A Migration of *Anosia plexippus* in Ohio. 8 min. Herbert Osborn
19 The Variability of Zygospores in *Spirogyra quadrata* formed by Scalariform and by Lateral Conjugation, and its bearing on the Theory of Amphimixis. 10 min. L. B. Walton
20 Some Observations concerning the effects of Freezing on Insect Larvæ. 6 min. J. S. Hine

Adjourn at 5:00 p. m. for a 15-minute recess.

5:15 p. m.

21 The Status of American Lichenology. Bruce Fink
22 Stains for Embryonic Skeletons. 10 min. E. L. Rice
23 A note on the Occurrence of *Typhlopsylla octactenus* in Ohio. 5 min. Herbert Osborn
24 The Development of the Swimming Movement in Amphibian Embryos. 10 min. G. E. Coghill
25 Natural History Notes from Hamilton Co., Ohio. 10 min. Charles Dury
26 Some Rare and Unnamed Mushrooms found in the Cuyahoga Valley. [Lantern Slides.] 5 min. G. D. Smith
27 Report on a New Pathogenic Pirosome. 5 min. E. F. McCampbell
28 The Marine Biological Survey of the San Diego [California] Region. 10 min. B. M. Davis
29 The Development of a Kelp. 15 min. R. F. Griggs
30 Regeneration and Inheritance. Sergius Morgulis
31 The Gold Fish—*Carassius auratus* L.—and its Color. 12 min. L. W. Sauer
32 A New Experiment in Ionization. 10 min. F. J. Hillig
33 The Lateral Line Organs of Ameiurus. 8 min. F. L. Landacre
34 Annual Report on the Ohio State Herbarium for 1907. W. A. Kellerman and Freda Detmers
35 Notes on Philomycus. 5 min. V. Sterki
36 Observations on the Life History and Adaptation of a New Semi-Aquatic Aphid, *Aphis aquaticus*. 8 min. C. J. Jackson
37 Variation in Temperature and Light Intensity when growing plants under cloth of different Colors. W. A. Kellerman and G. W. Hood

38 One Hundred Species of Mushrooms of the Cuyahoga Valley. 15 min. [Lantern Slides.] — G. D. Smith

39 Some Homologies between the Mouth Parts and Walking Appendages in the Hexapoda. 5 min. — L. B. Walton

40 Ancient Finger Lakes in Ohio. 11 min. — G. D. Hubbard

41 A Deposit of Glass Sand at Toboso, O. [Slides] 10 min. — Frank Carney

42 The Origin of Spring Valley Gorge near Granville, O. [Slides] 15 min. — Earl R. Scheffel

43 Extra-morainic Drift in the Baraboo area, Wisconsin. [Slides] 15 min. — Kirtly F. Mather

Stratigraphical studies in Mary Ann Township, Licking Co., O.:

44 Distribution of Formations. [Slides] 10 min. — Frank Carney

45 A Phase of the Sharon. [Slides] 10 min. — William C. Morse

46 Two Notable Landslides. 9 min. — Geo. D. Hubbard

47 Pleistocene Deposits at Clay Lick, O. [Slides] 15 min. — Kirtly F. Mather

48 A Group of Eskers South of Dayton, O. [Slides] 15 min. — Earl R.Scheffel

49 An Overflow Channel of a Glacial Lake in Yates Co., N. Y. [Slides] 10 min. — Frank Carney

50 High Level Terraces in S. E. Ohio. 12 min. — G. D. Hubbard

51 An Ecological Classification of the Vegetation of Cedar Point. — O. E. Jennings

Gambier, O., Dec. 15, 1907.

L. B. WALTON, *Secretary.*

Proceedings

of the

Ohio State

Academy of Science

VOLUME V, PART 4

Seventeenth Annual Report

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume V, Part 4

Seventeenth Annual Report

of the

Ohio State Academy of Science 1908

Organized 1891 Incorporated 1892

Publication Committee

J. C. Hambleton E. L. Rice Bruce Fink

Date of Publication, September 10, 1909

Published by the Academy
Columbus, Ohio

Officers — 1908-1909

PRESIDENT.

JOHN H. SCHAFFNER.

VICE-PRESIDENTS.

L. G. WESTGATE. S. R. WILLIAMS.

SECRETARY.

L. B. WALTON.

TREASURER.

J. S. HINE.

LIBRARIAN.

W. C. MILLS.

EXECUTIVE COMMITTEE.

Ex-Officio.

J. H. SCHAFFNER. JAS. S. HINE. L. B. WALTON.

Elective.

CHAS. BROOKOVER. J. WARREN SMITH.

BOARD OF TRUSTEES.

W. R. Lazenby, Chairman, term expires.......................... 1909
Frank Carney, term expires.......................... 1910
E. L. Rice, term expires.......................... 1911

PUBLICATION COMMITTEE.

J. C. Hambleton, Chairman, term expires.......................... 1909
E. L. Rice, term expires.......................... 1910
Bruce Fink, term expires.......................... 1911

Past Officers

PRESIDENTS.

1892. E. W. Claypole,
1893. Edward Orton,
1894. F. M. Webster,
1895. D. S. Kellicott,
1896. A. A. Wright,
1897. W. A. Kellerman,
1898. W. G. Tight,
1899. G. F. Wright,
1900. Josua Lindahl,
1901. A. D. Selby,
1902. W. R. Lazenby,
1903. C. J. Herrick,
1904. E. L. Moseley,
1905. Herbert Osborn,
1906. E. L. Rice,
1907. Charles Dury,
1908. Frank Carney.

VICE-PRESIDENTS.

1892. A. A. Wright, Ellen E. Smith.
1893. D. S. Kellicott, D. L. James.
1894. G. H. Colton, Mrs. W. A. Kellerman.
1895. H. E. Chapin, Jane F. Winn.
1896. A. L. Treadwell, Charles Dury.
1897. C. E. Slocum, J. B. Wright.
1898. Josua Lindhall, J. H. Todd.
1899. Chas. E. Albright, A. D. Selby.
1900. J. A. Bownocker, Lynds Jones.
1901. H. Herzer, Mrs. W. A. Kellerman.
1902. C. J. Herrick, C. S. Prosser.
1903. J. A. Bownocker, Miss L. C. Riddle.
1904. Lynds Jones, L. H. McFadden.
1905. C. W. Dabney, F. M. Comstock.
1906. Charles Dury, Lynds Jones.
1907. W. F. Mercer, Frank Carney.
1908. J. H. Schaffner, F. C. Waite.

TREASURERS.

1892-95. A. D. Selby,
1896-98. D. S. Kellicott,
1899-04. Herbert Osborn,
1905-09. Jas. S. Hine.

LIBRARIAN.

1904-09. W. C. Mills.

SECRETARIES.

1892. W. R. Lazenby,
1893-94. W. G. Tight,
1895-03. E. L. Moseley,
1904. F. L. Landacre,
1905-09. L. B. Walton.

TRUSTEES.

1900-04. F. M. Webster,
1900-02. H. C. Beardslee,
1904-06. C. J. Herrick,
1900-05. J. H. Schaffner,
1901-09. W. R. Lazenby,
1905-08. G. B. Halsted,
1907-08. Chas. Dury.
1908. Frank Carney,
1908. E. L. Rice.

PUBLICATION COMMITTEE.

1892-01. F. M. Webster,
1892-97. W. A. Kellerman,
1892-96. E. W. Claypole,
1897-99. E. L. Moseley,
1898-00. S. Belle Craver,
1900-08. J. H. Schaffner,
1901-03. L. H. McFadden,
1902-04. Gerard Fowke,
1904-05. Jas. S. Hine,
1905-09. E. L. Rice,
1906-09. J. C. Hambleton,
1908. Bruce Fink.

Membership

MAY 1, 1908.

Life Member

McMillin, Emerson E.........320 Riverside Drive, New York, N. Y.

Patron

Slocum, C. E...Defiance

Active Members

Aiken, W. H.....................................Station K, Cincinnati
Albright, Charles E......................................Columbus
Armstrong, C. A., *Geology*..................1110 Chance Ave., Canton
Bachman, Freda M., *Biology*............310 Bruen St., Madison, Wis.
Bales, B. R., *Ornithology, Entomology*......151 W. Main St., Circleville
Ball, E. D., *Entomology*.................................Logan, Utah
Ballard, C. McB., *Biology*........Johns Hopkins Univ., Baltimore, Md.
Banta, A. M., *Biology*.......................................Marietta
Beekman, W. S., *Geol., Mineral, Chemistry*.....................
..................Cincinnati Society of Natural History, Cincinnati
Bell, Edith C., *Biology*..................................Mt. Vernon.
Benedict, H. M........................Univ. of Cincinnati, Cincinnati
Berger, E. W., *Zoology*.............................Gainesville, Florida
Bing, S. H., *Botany, Zoology*..................................Bidwell
Black, J. G..................................R. F. D. No. 10, Wooster
Blackman, M. W.........Western Reserve Medical College, Cleveland
Blair, Kate R............................1501 Neil Ave., Columbus
Bolin, W. C., *Engineering*.....................R. F. D. No. 1, Newark
Bonser, T. A., *Botany, Geology*......2217 Monroe St., Spokane, Wash.
Bownocker, John A., *Geology*.......................O. S. U., Columbus
Box, Cora May, *Zoology*...............Univ. of Cincinnati, Cincinnati
Braam, Maximilian, *Biology*..........Hughes High School, Cincinnati
Branson, E. B..Oberlin
Breese, B. B., *Psychology*...............Univ. of Cincinnati, Cincinnati
Brockett, Ruth E., *Botany*..................................Rio Grande
Brookover, Chas. ....Buchtel College, Akron
Brugger, Harvey, *Botany*.....................218 N. Wood St., Fremont
Bubna, Matthias, *Entomology*..........2629 Woodhill Road, Cleveland

BUDINGTON, R. A., *Zoology, Physiology*..........................Oberlin
BURGESS, A. F., *Entomology*........U. S. Dept. Ag., Washington, D. C.
BURKE, R. H., *Geology and Geography*........................Oxford
CARNEY, FRANK, *Geology*..................................Granville
CLAASSEN, EDO., *Botany*..............18 Fernwood Ave., East Cleveland
CLARK, HOWARD, *Geology*..................................Granville
CLEVENGER, J. F., *Botany*...............Wheaton College, Wheaton, Ill.
COBERLY, E. D., *Meteorology, Botany*....Weather Bureau, Helena, Mont.
COGHILL, GEO. E., *Zoology, Neurology*......................Granville
COLE, A. D., *Physics*......................................Columbus
COLTON, GEORGE H..Hiram
COMSTOCK, FRANK M., *Vert. Zoology*............Case School, Cleveland
COTTON, E. C., *Entomology*..........Experiment Sta., Knoxville, Tenn.
COPELAND, W. F..Athens
CRAMER, WILLIAM G., *Zoology*............273 Southern Ave., Cincinnati
DABNEY, CHAS. W......................Univ. of Cincinnati, Cincinnati
DACHNOWSKI, ALFRED, *Botany*.......................O. S. U. Columbus
DAVIES, CLARA A., *Botany, Physics*..........................Granville
DAVIS, V. H., *Horticulture*........................O. S. U., Columbus
DETMERS, FREDA, *Botany*..........................O. S. U., Columbus
*DOREN, JANE MACARTNEY, *Botany, Zoology*......................
................................1659 Franklin Park South, Columbus
DUNLAP, FREDERICK, *Forestry*....U. S. Forest Service, Washington, D. C.
DURRANT, E. P., *Biology, Geology*.........................Westerville
DURY, CHAS. ....537 Ridgway Ave., Cincinnati
DUTTON, C. F., JR......................4816 Franklin Ave., Cleveland
EDWARDS, E. H., *Zoology, Physiology*............................
................................7317 Clinton Ave., N. W., Cleveland
FEIEL, ADOLPH ....520 E. Main St., Columbus
FENNEMAN, N. M., *Geology, Geography*...Univ. of Cincinnati, Cincinnati
FETZER, BERTHA A., *Zoology*................................Granville
FINK, BRUCE, *Botany, Zoology*..............................Oxford
FISCHER, WALTER, *Botany*..........U. S. Dept. of Agr., Bureau of
Plant Industry, Washington, D. C.
FISCHBACH, H. P., *Biology*...........................Newport, Ky.
*FITZGERALD, A. D., *Histology, Pathology*...........O. S. U., Columbus
*FLETCHER, M. H..............................11 E. 7th St., Cincinnati
FLYNN, MAUD, *Zoology*....................338 W. 6th Ave., Columbus
FOLTZ, H. L., *Biology*...............................Box 286, Lima
FOOTE, E. H., *Biology*...................................Granville
*FOX, CHAS. P., *Botany, Chemistry*................395 Doyle St., Akron
FOWKE, GERARD, *Glacial Geology, Archaeology*...................
.....................................105 N. 2d St., St. Louis, Mo.

* Subject to ratification by the society at the annual meeting, 1909.

Frank, J. N., *Botany, Entomology*........................Hurley, Va.
Fullmer, E. L., *Botany*..Berea
Gary, L. B., *Geology*.....................12 Dewitt St., Buffalo, N. Y.
Gibbs, David ....Milan
Gregory, W. M.................................116 Olive St., Cleveland
Grover, F. O., *Botany*...Oberlin
Griggs, R. F., *Botany*....................1318 Forsythe Ave., Columbus
Guyer, M. F............................Univ. of Cincinnati, Cincinnati
Halsted, G. B., *Mathematics*.................Box 68, Greeley, Colorado
Hambleton, J. C., *Botany, Zoology*..........212 E. 11th Ave., Columbus
Hansen, Mrs. Hermina J., *Biology*....Hughes High School, Cincinnati
Hartzel, J. C................Univ. of the Pacific, San Jose, California
Harvey, Ruth, S., *Ornithology*........1203 Woodland Ave., Bond Hill
Harvey, Gertrude F., *Ornithology*......1203 Woodland Ave., Bond Hill
Hawk, J. F., *Biology*..............................Box 302, Lancaster
Hawkins, L. A., *Botany*.......Bureau of Plant Ind., Washington, D. C.
Hayes, Seth.....................................42 Liberty St., Dayton
Heilman, Wm. T...................................Canal Winchester
Henninger, W. F., *Ornithology, Entomology*.............New Bremen
Herms, W. B.......................Univ. of California, Berkeley, Cal.
Herzer, H., *Paleontology*......................................Marietta
Hillig, Fred J...............................St. John's College, Toledo
Hine, J. S., *Entomology, Ornithology*.............O. S. U., Columbus
Hobbs, P. L., *Chemistry*......Western Reserve Med. College, Cleveland
Hoke, Geo. W., *Geography, Biology*............................Oxford
Holt, W. P., *Botany*.........................2113 Putnam St., Toledo
Houk, Eliza P. T., *Chemistry*.................................Dayton
Houser, J. S., *Entomology*................Santiago de las Vegas, Cuba
Hubbard, G. D., *Geology, Physiography*...........O. S. U., Columbus
Hyde, J. E., *Geology*..Lancaster
Jackson, C. F., *Zoology*..................................Durham, N. H
James, C. B.................................Adelbert College, Cleveland
Jennings, O. E., *Botany*........Carnegie Museum Annex, Pittsburg, Pa.
Johnson, A. A., *Biology*............................Box 582, Athens
Jones, Lynds, *Ornithology*.....................College Museum, Oberlin
Jones, Robt. Ralston, *Geology*........U. S. Engineer's Office, Cincinnati
Judson, C. A., *Botany*.....................235 Columbus Ave., Sandusky
Landacre, F. L., *Zoology*.........................O. S. U., Columbus
Lazenby, Wm. R., *Horticulture, Botany*..............O. S. U., Columbus
Lee, Mary E., *Geology*.....................................Westerville
Lett, Gertrude, *Biology*......................................Granville
Library, Ohio State University...............................Columbus
Lindahl, Josua, *Zoology*..................5700 Peoria St., Chicago, Ills.
Lloyd, John Uri.........................Court and Plum Sts., Cincinnati

Mackenzie, Mary D., *Biology*....................................Oxford
Mally, C. W., *Entomology*.................... Grahamstown, S. Africa
March, Cora, *Biology*....................................Wyoming
Masterman, E. E., *Zoology, Botany*.......................New London
Matheny, W. A......................Clark University, Worcester, Mass.
Mather, Kirtley F., *Geology*..............................Granville
Mathews, Mary E..Painesville
McCall, A. G., *Agronomy*.........................O. S. U., Columbus
McCampbell, Eugene, F., *Bacteriology*..............O. S. U., Columbus
McCaughey, Vaughan, *Biology*....475 Manhattan Ave., New York, N. Y.
McConnell, Harry B., *Ornithology*...........................Cadiz
McCoy, C. T., *Botany*....................................Lancaster
McCray, Arthur H., *Zoology and Entomology*..................Duval
McDaniel, J. E., *Biology*............................La Junta, Colo.
McElhinney, Frank B., *Botany*..........................New London
McFadden, L. H., *Chemistry*..................40 Warden St., Dayton
McKean, T. L., *Botany*..Berea
Mead, Chas. S., *Zoology, Botany*...............217 King Ave., Columbus
Mercer, W. F., *Biology*......................Ohio University, Athens
Metcalf, M. M., *Zoology*......................................Oberlin
Metcalf, Zeno P..Raleigh, N. C.
Mills, W. C., *Archaeology, Biology*..................O. S. U., Columbus
Moody, A. E...Flushing
Morgulis, S., *Zoology*...................Harvard Univ., Cambridge, Mass.
Morse, W. C., *Biology, Geology*......................O. S. U., Columbus
Morris, C. H., *Ornithology*.............................McConnelsville
Moseley, E. L., *Zoology, Botany, Physiography*...............Sandusky
Nelson, James A., *Zoology, Embryology*..........................
U. S. Dept. Agricul. Div. Entom. Washington, D. C.
Oberholser, H. C...........1445 Girard St., N. W., Washington, D. C.
Odenbach, F. L., *Meteorology*............St. Ignatius College, Cleveland
Osborn, Herbert, *Entomology, Zoology*..............O. S. U., Columbus
Osburn, Raymond C., *Zoology, Ichthyology*.......................
Columbia Univ., New York, N. Y.
Oxley, Chas. E., *Geology, Physics*..........................Coshocton
Pallister, H. D.....................3754 Independence Road, Cleveland
Parkhurst, C. P., *Science*.....................9 W. Long St., Columbus
Peaslee, L. D., *Zoology*..........................U. of C., Cincinnati
Pickel, Geo. J., *Chemistry*..............St. Ignatius College, Cleveland
Piwonka, Thomas ....226 Superior Ave., N. W., Cleveland
Porterfield, J. C...................916 New Hayden Building, Columbus
Prosser, C. S., *Geology*..............................O. S. U., Columbus
Pumphrey, J. Homer, *Ornithology*.............................Clayton
Rice, Edward L., *Zoology*....................................Delaware

Roudebush, Lowell ....R. F. D. No. 3, New Richmond
Royer, John S., *Biology*....................................Bradford
Sanders, J. G., *Entomology, Botany*..U. S. Dept. Agr., Washington, D. C.
Sanders, A. E...........................Steele High School, Dayton
Sanger, U. G., *Botany*....................................Newark
Sauer, Lewis W., *Botany*...Central Ave. and Bay Miller St., Cincinnati
Schaffner, J. H., *Botany*..........................O. S. U., Columbus
Scheffel, Earl R., *Geology*.............469 College Ave., Appleton, Wis.
Scott, L. L.; *Entomology*..................Experiment Station, Wooster
Seaton, Miss F............................1943 E. 86th St., Cleveland
Seley, A. D., *Botany*.....................Experiment Station, Wooster
*Sessions, Elizabeth, *Botany and Zoology*....59 Wilson Ave., Columbus
Shatzer, C. G.........................Wittenberg College, Springfield
Shaw, N. E., *Entomology*.........................O. S. U., Columbus
Sim, Robert J......................................O. S. U., Columbus
Smith, A. L., *Geology*.....................175 W. 10th Ave., Columbus
Smead, Anna, *Biology*.............................624 Nestle St., Toledo
Smith, Ethel M.............................122 Center St., Ashtabula
Smith, G. D., *Botany, Zoology*....................Richmond, Kentucky
Smith, J. Warren, *Meteorology*............Weather Bureau, Columbus
Smyth, Lumina C. Riddle, *Botany*.........State House, Topeka, Kans.
Snyder, F. D., *Zoology, Ethnology*.............................Ashtabula
Stair, L. D..................................92 Wadena St., Cleveland
Stauffer, Clinton R., *Geology*..................................Berea
Sterki, Victor, *Conchology, Botany*...................New Philadelphia
Stickney, M. E., *Botany*.....................................Granville
Stockberger, W. W., *Botany*......Dept. Agriculture, Washington, D. C.
Stoner, Minnie A., *Domestic Science*................Laramie, Wyoming
Stout, W. E., *Chemistry, Geology*..........1960 N. High St., Columbus
Surface, F. M., *Zoology, Botany*.........................Orono, Maine
Sweezey, Otto H.........................12th Ave., Honolulu, Hawaii
Tight, W. G., *Geology*..........................Albuquerque, N. M.
Todd, Joseph H., *Geology, Archaeology*....Christmas Knoll, Wooster
Todd, Otto K...Vermillion
Thomas, Lewis, *Geology*.....................................Granville
True, H. L...McConnelsville
Tyler, F. J., *Botany*..............................Perry, Lake County
Van Hook, J. M., *Plant Pathology*..........Experiment Station, Wooster
Waite, F. C.....................Western Reserve University, Cleveland
Walton, L. B., *Biology*.......................................Gambier
Webb, R. J., *Botany*....................................Garrettsville
Webster, F. M., *Entomology*..U. S. Dept. Agriculture, Washington, D. C.

* Subject to ratification by the Society at the annual meeting in 1909.

WERTHNER, WILLIAM, *Botany*................Steele High School, Dayton
WESTGATE, LEWIS G., *Geology*................................Delaware
WETZSTEIN, A. *Botany*............748 Pleasant St., Hot Springs, Arkansas
WIEMAN, HARRY L., *Biology*.............Univ. of Cincinnati, Cincinnati
WILLIAMS, STEPHEN R., *Biology*..............Miami University, Oxford
WILLIAMSON, E. BRUCE, *Ichthyology, Ornithology*.........Bluffton, Ind.
WILSON, STELLA S., *Geography, Geology* 97 N. 20th St., Columbus
WINELAND, L. A., *Chemistry*..............................Westerville
WITTENMYER, J. G., *Zoology*..................................Peebles
WOLFE, E. E., *Botany*.......................Marietta College, Marietta
WRIGHT, G. FREDERICK, *Geology*..............................Oberlin
YORK, HARLAN H., *Botany*...............Univ. of Texas, Austin, Texas
YOUNG, R. A., *Botany*.....................................
Div. Seed and Plant Introduction, Washington, D. C.

Report of the Eighteenth Annual Meeting

of the

Ohio State Academy of Science

ANNUAL MEETING

The eighteenth annual meeting of the Academy was held at Denison University, Granville, O., on November 26, 27 and 28, the President, Prof. Frank Carney, presiding On Thursday evening a reception was given at the residence of President and Mrs. Emory W. Hunt, of the University, where refreshments were served and a most delightful evening was passed by the considerable number of members present. The university authorities had generously placed the dormitories at the disposal of the society while arrangements for meals had been made in the town.

After an informal session of various committees the meeting was called to order by the President of the Academy at 9:00 Friday morning in Barney Memorial Hall. A brief address extending the cordial greetings of the University to the society was made by President Hunt, after which occurred the regular business meeting.

The President called attention to the loss sustained by the society through the deaths of three members since the last annual meeting, Prof. W. A. Kellerman of Ohio State University, Hon. Joseph H. Outhwaite, and John J. Janney. The life of Prof. Kellerman was sacrificed to science, his death resulting from a tropical fever while on a collecting expedition in Guatemala, Central America. He served the society as President in 1897, and rarely an annual meeting occurred that his interest was not manifested through his attendance and participation in the program. Both Mr. Outhwaite and Mr. Janney who were also residents of Columbus, lived long and useful lives, and at various times signified their interest in the affairs of the Academy, Mr. Janney died at the advanced age of 96 years.

After the appointment by the chair of a committee on membership consisting of Professors Osborn, Fink, and Stickney, and a committee on resolutions consisting of Professors Rice, Williams, and Griggs, the report of the Secretary was presented and accepted. This was followed by the report of the Treasurer, Prof. J. S. Hine, which after being referred to an auditing committee consisting of Prof. Lazenby and Prof. Brookover, was accepted. The report of the Treasurer is as follows:

Report of the Treasurer for the Year 1908.

For the year since our last annual meeting the receipts, including balance from last year, have amounted to $169.56, and the expenditures to $154.99, leaving a cash balance of $14.57.

RECEIPTS.

Balance from last year	$0 56	
Membership dues	169 00	
Total		$169 56

DISBURSEMENTS.

180 subscriptions to the Ohio Naturalist	$90 00	
Miscellaneous	64 99	
Balance December 1, 1908	14 57	
Total		$169 56

Respectfully submitted,

James S. Hine.

REPORT OF THE LIBRARIAN 1907-08.

The report of the Librarian of the Society, Prof. W. C. Mills, is as follows:

November 27, 1908.

As Librarian of the Ohio State Academy of Science, I take pleasure in presenting to the Treasurer of the Academy, my report upon the receipts from the sale of the publications of the Academy.

Amount on hand, December 1st, 1907............	$0 09	
Sale of Reports and Special Papers...............	14 25	
Publications sold but money not collected..........	2 10	
		$16 44
Expenditures for 1908:		
Postage of Special Paper No. 13..................	$4 10	
Postage of Annual Report.........................	4 00	
Express and Postage	4 80	
		$12 90
Cash on hand		$3 54

Wm. C. Mills,
Librarian.

Prof. Lazenby, chairman of the Board of Trustees, presented the following report which was approved and accepted. Mention was made of the continued interest in the welfare of the Society manifested by Mr. Emerson McMillin through his gift of an additional $250.00 to the "Emerson McMillin Research Fund." The report of the trustees is as follows:

REPORT OF THE BOARD OF TRUSTEES.

The financial statement of the Emerson McMillin research fund, for the year 1907-08, is herewith presented:

RECEIPTS.

1907.			
	Balance on hand, Nov. 1, 1907..............	$358 23	
	Check from Emerson McMillin, received November 11, 1907......................	250 00	
	Total		$608 23

EXPENDITURES.

1908.			
Feb.	21.	Dr. A. Dechnowski — Expense in research..	$16 80
Mar.	27.	Dr. A. Dechnowski — Expense in research..	8 35
Apr.	28.	F. J. Heer Printing Co., 350 copies "Protozoa of Ohio," by F. L. Landacre............	40 00
May	12.	Dr. A. Dechnowski — Expense in research..	8 71
	22.	H. S. Hammond — Expense in research....	9 10
	27.	Sergius Morgulis — Expense in research.....	7 09
	28.	H. S. Hammond — Expense in research......	6 00

June	9.	Dr. A. Dechnowski — Expense in research..	6 14
	11.	H. S. Hammond — Expense in Research.....	6 00
	16.	H. S. Hammond — Expense in research......	3 50
July	6.	Prof. L. B. Walton — Expense in research..	6 75
Aug.	3.	Prof. L. B. Walton — Expense in research..	20 12
		Total	$138 56

Balance on hand November 1, 1908, $469.67.

A check for $250.00 was received from Emerson McMillin, Nov. 7, 1908. This together with the balance reported is deposited in the Capital City Bank, Columbus.

William R. Lazenby,
Chairman.

The Publication Committee consisting of Professors J. C. Hambleton, Chairman, J. H. Schaffner, and E. L. Rice, presented the following report which was accepted:

REPORT OF THE PUBLICATION COMMITTEE.

During the year two papers have been published. Special paper No. 13, The Protozoa of Sandusky Bay and Vicinity, by F. L. Landacre, containing 52 pages, completed Vol. IV of the Proceedings, which consists of ten parts. The Seventeenth Annual Report, containing 18 pages constitutes Part 1 of Vol. V of the Proceedings.

Under the report of special committees, Prof. Herbert Osborn as chairman of the committee on the Natural History Survey, mentioned the work which had been done in the effort to secure the passage of the bill. It was the sense of the society that the committee should be continued.

Professor L. B. Walton, chairman of the committee on the Revision of the Constitution and By-Laws submitted the proposed Constitution and By-Laws which had previously been printed and distributed to members with the Ohio Naturalist. After a brief discussion, two additional members, J. Warren Smith and Bruce Fink were placed on the committee which in addition to the chairman, consisted of E. L. Rice and F. L. Landacre. The final report of this committee was presented at the subsequent business meeting, and the new Constitution and By-

Laws ordered published in the Proceedings of the Academy. They will be found on subsequent pages.

The secretary as chairman of the committee appointed to consider the advisability of holding joint meetings with the Indiana Academy of Science, reported the correspondence with the secretary of the Indiana Academy, Prof. J. H. Ransom, of Purdue University. There seemed no doubt as to the value to both societies resulting from such a meeting, although plans already made by the Indiana Academy may make it necessary to defer such co-operation until the November meeting in 1910.

After the election of a nominating committee consisting of Professors Osborn, Rice, and Stickney, the business meeting was adjourned until Saturday morning at 8:00 a. m. while the society proceeded with the reading of papers, adjourning at 12 o'clock for luncheon.

The afternoon session opened with the address of the President, Professor Frank Carney, on "The Raised Beaches of the Berea, Cleveland, and Euclid Quadrangles." The section in Biology then met in room "A" the section in Geology remaining in room "B," and the program was continued.

After a recess of 10 minutes, the society convened as a body to listen to papers on "The Preservation and Development of the Natural Resources of Ohio." Professor J. A. Bownocker opened the discussion from the standpoint of Geology, followed by Professor W. R. Lazenby, who presented the Forestry side of the question, while Professor Herbert Osborn considered it from the Biological point of view. An interesting discussion followed. Adjournment was then made for the afternoon.

In the evening the society listened to an interesting address by Professor R. S. Tarr, of Cornell University, on "The Glaciers of Mount St. Elias and Vicinity." This was illustrated by lantern slides.

Saturday at 8:00 a. m. occurred the adjourned business meeting. The report of the nominating committee was received and the following officers were elected for the ensuing year:

President — Professor J. H. Schaffner, Columbus, O.
Vice-Presidents — Professor L. G. Westgate, Delaware, O., Professor S. R. Williams, Oxford, O.
Secretary — Professor L. B. Walton, Gambier, O.
Treasurer — Professor J. S. Hine, Columbus, Ohio.
Executive Committee — Professor Chas. Brookover, Akron, Ohio; Mr. J. Warren Smith, Columbus, Ohio.
Board of Trustees — Professor Frank Carney, Granville, Ohio, 2 years; Professor E. L. Rice, Delaware, Ohio, (in place of retiring member) 3 years.
Publication Committee — Professor Bruce Fink, Oxford, Ohio, (in place of retiring member).

The following members were elected by the executive committee during the year:

Budington, R. A., Zoology, Physiology..........................Oberlin
Coons, C. D., Physics..Granville
Davies, Clara A., Botany, Physics..............................Granville
Fetzer, Bertha A., Zoology.....................................Granville
Johnson, T. B., Physics..Granville
Lett, Gertrude, Biology..Granville
Metcalf, M. M., Zoology..Oberlin
Mossman, Madge C., Geology.....................................Granville
Orcutt, A. S., Botany..Granville
Shaw, N. E., Entomology..................Columbus, Dept. Agriculture
Stout, W. E., Chemistry, Geology...........1960 N. High St., Columbus
Trask, B. E., Engineering......................................Granville
Thomas, Lewis, Geology...Granville

The membership committee appointed by the President at the opening session reported on the following who were duly elected:

Bell, Edith C., Biology..Mt. Vernon
Clark, Howard, Geology...Granville
Oxley, Chas. E., Geology, Physics..............................Coshocton
Parkhurst, C. P., Science......................9 W. Long St., Columbus
Peaslee, L. D., Zoology..................Univ. of Cincinnati, Cincinnati
Scott, L. L., Entomology.......................65 16th Ave., Columbus
Smith, A. L., Geology.........................175 W. 10th Ave., Columbus
Wilson, Stella A., Geography, Geology..........97 N. 20th St., Columbus
Wineland, L. A., Chemistry.....................................Westerville

The names noted below have been approved by the incoming executive committee and are subject to election at the next annual meeting in accordance with article V, section 1, of the new constitution.

Fitzgerald, Dr., Histology, Pathology, O. S. U., Columbus.
Fox, Chas. P., Botany, Chemistry, 395 Doyle St., Akron.
Reinheimer, B. H., Biology, Sandusky, Ohio.

The committee on resolutions reported as follows:

Be it Resolved, That we, members of the Ohio Academy of Science, hereby express our sense of loss in the death, since our last meeting, of three of our members, John J. Janney, Joseph H. Outhwaite, and William A. Kellerman, the latter a charter member of the Academy and president in 1897, and at all times an ardent and enthusiastic supporter of the work and ideals of our organization.

Be it further Resolved, That we signify to Mr. Emerson McMillin our great appreciation of his continued interest in the efforts of the Academy, and for his substantial contributions to the support of the projects of the same, and that we extend to him our sincere thanks for his numerous favors.

Be it further Resolved, That we extend our heartiest thanks to the President and Faculty of Denison University who have so hospitably opened their homes to the visiting members, and to the authorities of the University and the members of the Local Committee for their efficient contributions to the marked success of the Eighteenth Annual Meeting of the Academy.

Edward L. Rice,
R. F. Griggs,
S. R. Williams.

In connection with exchanges received by the society, it was moved, seconded and carried that the librarian be requested to furnish a report of such exchanges at the next annual meeting.

Professor Hubbard made a report for the Library Committee. The report was accepted, the committee continued, and the final report ordered printed in the Ohio Naturalist.

The Committee on the Conservation of the Natural Resources of Ohio consisting of Professor Herbert Osborn, Professor Wm. Lazenby, and Professor J. A. Bownocker presented the following report. The committee was continued and empowered to add two new members. The members added were J. Warren Smith of Columbus, and L. B. Walton of Gambier.

The Ohio Academy of Science at its session in Granville, November 27 and 28, 1908, after a special program devoted to the discussion of the conservation of the natural resources of the state, adopted the following resolutions as expressing its position in regard to the importance and necessity of active measures for state conservation:

Resolved, That it is the desire of this Academy to place itself on record as favoring active efforts in support of the movement for rational protection of the resources of the country; that we cordially indorse the movement that has resulted in the formation of a National Conservation Commission, and urge the extension of its powers that it may direct the movement to a practical end.

We recognize the need in Ohio for action in the conservation of coal, and urge that measures providing for national control be enacted where state supervision is impracticable. We urge the importance of forest conservation and extension as a vital necessity for the future welfare of the state, and the formation of a forestry commission or establishment of a state forest service at the earliest possible time.

We recognize the necessity of immediate attention to the waterways and measures to conserve and utilize the possibilities for power, irrigation and navigation in the water areas, and of a scientific investigation of the biological resources connected with aquatic life, and urge the passage of a bill to establish a Biological Survey.

We would urge the formation by the Governor or General Assembly of a State Conservation Commission, at least one-half the members to be men of scientific training, to consider and report to the Government on important measures for conservation.

We recommend a Committee on Conservation in the Academy, and the arrangement for our next annual meeting of a special session devoted to a discussion of the questions pertaining to the conservation of the resources of the State.

J. A. Bownocker,
W. R. Lazenby,
Herbert Osborn,
Committee.

In connection with the discussion of the value of geological and biological excursions for students in the secondary schools, by Professor Hubbard, it was voted that a committee be appointed by the President of the society to report at the next annual meeting.

A telegram was received from the Indiana Academy of Science then in session, conveying the good will of the members of that society to the Ohio Academy. The following reply was sent: "The Ohio Academy of Science cordially reciprocates the greetings of the Indiana Academy of Science."

At the close of the business session the society proceeded with the reading of the papers.

At 11:45 a. m. the Academy was formally declared adjourned.

The complete program of the meeting was as follows:

1. Notes on *Spondylomorum quaternarium* Ehrb. 3 min. — M. E. Stickney
2. The Pteridophyte Flora of Ohio. 5 min. — J. H. Schaffner
3. Injury to Trees by the season's Drouth. 5 min. — W. R. Lazenby
4. Snails collected at Cedar Point, Ohio, during July, 1908. 5 min. — S. R. Williams and J. K. Breitenbecher
5. The Making of a Naturalist's Directory. 5 min. — F. J. Hillig
6. The Occurrence of a New Species of Land Planarian in Ohio, with notes on the common species, *Rhynchodemus sylvaticus* Leidy. 5 min. — L. B. Walton
7. The Behavior of The Opossum (*Didelphys virginiana*). 5 min. — G. E. Coghill
8. Differentiation of the general Cutaneous and Visceral ganglia in *Ameiurus*. 12 min. — F. L. Landacre
9. Some Aspects of Amitosis in Synchytrium. 5 min. — R. F. Griggs
10. Direction of Flow of Encephalic Fluid in *Amia calva* L. 5 min. — Chas. Brookover
11. Recent Evaporation Investigations. 12 min. — J. Warren Smith

12. Adaptation in a Desert Lichen Flora. 10 min. Bruce Fink
13. Notes on the Ohio Flora. 5 min. J. H. Schaffner
14. The Laboratory Method for Beginning Students. 10 min. Maximilian Braam
15. Protective Encystment in *Phagocata gracilis*. 5 min. L. D. Peaslee
16. Cell Division in the Pollen Mother Cells of *Anthemis cotula* L. 8 min. M. E. Stickney
17. Mitosis in Opalina. 15 min. M. M. Metcalf
18. A Preliminary Report on the Nuclear Divisions in the Pollen Mother Cell of *Convallaria majalis* L. 5 min. L. W. Sauer
19. Is Synizesis an Artifact? 6 min. J. H. Schaffner
20. A Preliminary Note on the Chondrocranium of Eumeces. (Slides.) 10 min. E. L. Rice
21. Notes on the Growth of the Western Catalpa (*Catalpa speciosa*). 8 min. W. R. Lazenby
22. Faulty Specimens for Nature Study, and how Good Ones may be Prepared. 15 min. Chas. Dury
23. Cancer in Mice (*Mus musculus*). 5 min. E. F. McCampbell
24. Relation of Rain Fall to Crop Yield. 5 min. J. Warren Smith
25. Removal of the Showy Parts of Flowers as affecting Fruit and Seed Produced. 5 min. A. H. McCray
26. The Coals of the Monongahela Formation in Ohio. 25 min. J. A. Bownocker
27. Fresh light on the Chronology of the Glacial Epoch in North America. (Slides.) 25 min. G. F. Wright
28. Glacial Erosion in the Canadian Selkirks. (Slides.) 15 min. L. G. Westgate
29. Some effects of Glacial Erosion in the Alps. 10 min. N. M. Fenneman
30. The Raised Beaches of Lake Huron. 15 min. W. M. Gregory
31. Rock Terraces along Streams in the Vicinity of Columbus, Ohio. 12 min. G. D. Hubbard
32. Ecologic Notes from Beechwood Camp. 8 min. Bruce Fink
33. The Systematic Position of *Apathus elatus*. 8 min. A. H. McCray
34. Observations on the Tick, *Bryobia pratensis* Garman. 10 min. S. R. Williams
35. Occurrence of *Paragonimus westermannii* near Cincinnati, Ohio. 5 min. H. M. Benedict
36. Localization of the Excretory Function in *Amoeba proteus*. 7 min. M. M. Metcalf and R. A. Budington
37. Evidence pointing toward a Sexual Reproduction in *Euglena proxima* Dangr. 5 min. L. B. Walton

38. The Discomycetes of Oxford, Ohio.
Bruce Fink and Freda M. Bachman
39. Observations on Ohio Species of Disonycha. 5 min. L. L. Scott
40. Observations on Tube Making in Tubifex. 3 min. Cora M. Box
41. Venation of Leaves from Old and Young Plants. 10 min. H. M. Benedict
42. Some noteworthy Species of Plants in Ohio. 3 min.
O. E. Jennings
43. The Waverly Formations of East Central Kentucky. 20 min. W. C. Morse and A. F. Foerste
44. Valley Drift at St. Louisville, O. (Slides.) 7 min. Howard Clark
45. Well Records in Licking Co., Ohio. 5 min. Lewis Thomas
46. The Age of the Licking Narrows at Black Hand, Ohio. 20 min. K. F. Mather
47. Post Glacial Erosion of Plum Creek, Oberlin, Ohio. 10 min. G. F. Wright
48. Glacial Deposits Southwest of Wilkins Run, Ohio. 10 min. Madge Mossman
49. The Teaching of Historical Geology. 8 min. L. G. Westgate
50. Preglacial Channels in the Little Miami Valley. 10 min.
G. F. Wright
51. The Major Subdivisions of the Lower Silurian Strata in Ohio, with Particular Reference to the Richmond Formation recently mapped by the Ohio Geological Survey. 10 min. A. F. Foerste and W. C. Morse
52. The Value of Geology as an Educational Discipline. 15 min. L. G. Westgate
53. A New Anthracnose of Cereals and Grasses. 8 min.
A. D. Selby and T. F. Manus
54. The Reconstruction Method as Applied to Hollow Organs. 3 min. E. L. Rice

DEMONSTRATIONS.

1. Cytological Technique. M. E. Stickney
2. Charts Illustrating the Reaction of Diemyctylus Embryos to Tactile Stimuli. G. E. Coghill
3. Slide Showing Emergence of the Gametes (?) from the small spores arising from the repeated division of an "Encysted" Euglena. L. B. Walton
4. The "Larval" Form of an Interesting Pauropod, *Eurypauropus spinosus* Ryder. L. B. Walton

Gambier, Ohio, March 27, 1909.

L. B. Walton, *Secretary*.

CONSTITUTION.

ARTICLE I, NAME.

This society shall be known as the "Ohio Academy of Science."

ARTICLE II, OBJECTS.

The objects of this Academy shall be the promotion of scientific research and the diffusion of knowledge concerning the various departments of science.

ARTICLE III, MEMBERSHIP.

1. The Academy shall be composed of *Resident Members, Corresponding Members, Honorary Members*, and *Patrons*.

2. *Resident Members* shall be persons interested in scientific work and resident in the State of Ohio.

3. *Corresponding Members* shall be persons interested in science, and not resident in the State of Ohio.

4. *Honorary Members* shall be persons distinguished for their attainments in science, and not resident of the State of Ohio. Their number shall not exceed twenty-five.

5. *Patrons* shall be persons who have bestowed important favors upon the Academy as defined in the By-Laws.

6. Corresponding Members and Honorary Members are not entitled to vote or to hold office in the Academy.

ARTICLE IV, OFFICERS, COMMITTEES, ETC.

1. The officers of the Academy shall consist of a President, a Vice President of each Section organized, a Secretary, a Treasurer, a Librarian and three trustees of the Research Fund.

2. The President, Secretary, and Treasurer, together with two elective members shall constitute an *Executive Committee*.

3. The *Publication Committee* shall consist of three elective members.

4. The *Program Committee* shall consist of the Secretary and the Vice-Presidents of the various sections.

5. Three trustees elected in accordance with section 14 shall be designated as *Trustees of the Research Fund.*

6. *The President* shall discharge the usual duties of a presiding officer at all meetings of the Academy and of the Executive Committee. 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 annual meeting of the year for which he is elected.

7. The duties of the President in case of his absence or disability shall be assumed by one of the Vice-Presidents designated by the Executive Committee.

8. *The Vice-Presidents* shall be chairmen of their respective Sections. They shall further, with the Secretary acting as chairman, constitute a Program Committee to arrange for the presentation of papers at the annual meeting.

9. *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 co-operate with the President in attending to the ordinary affairs of the Society and also attend to the preparation, printing and mailing of circulars, blanks and notifications of elections and meetings. The Secretary shall superintend printing ordered by the Executive Committee, which is not within the province of the Publication Committee, and shall have charge of its distribution under direction of the Executive Committee. The Secretary shall also be chairman of the Program Committee as constituted in Section 4.

10. *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.

11. *The Librarian* shall have charge of the distribution of publications, and in so far as practicable, shall arrange exchanges with other societies. He shall furthermore act as cus-

todian of all property belonging to the Society. All books, periodicals, pamphlets, etc., belonging to the library shall be accessible for consultation by members of the Academy under such regulations as may be provided.

12. *The Executive Committee* is clothed with executive authority and with legislative powers of the Academy in the intervals between the regular annual meetings. No extraordinary act of the committee shall however remain in force beyond the next annual meeting unless ratified by the Academy. The Executive Committee shall receive nominations for membership and on approval shall submit such nominations to the Academy for action. It shall have the power to fill vacancies *ad interim* in any of the offices of the Academy.

13. *The Publication Committee* shall have charge of the preparation and publication of the Annual Report and of such other papers as may be considered by them desirable to have printed.

14. *The Trustees of the Research Fund* shall be three in number. They shall have charge of the allotment and distribution of the income or of the principal of the Research Fund.

15. *Terms of Office.* The President, Vice-Presidents, Secretary, Treasurer, and Elective Members of the Executive Committee and Publication Committee, shall be elected annually at the annual meeting, and shall be eligible to re-election without limitation, with the exception of the President, who shall not be elected for successive terms. The Librarian shall be elected for a period of three years. The Trustees of the Research Fund shall be elected for a term of three years. This shall be so arranged however that the expiration of the terms of office of no two trustees occurs in the same year.

ARTICLE V, VOTING AND ELECTIONS.

1. *Nomination of Members.* (a) Nominations for Resident Membership shall be made by two Resident Members in accordance with a form provided by the Executive Committee. One of such Resident Members must be acquainted with the

nominee and his qualifications for membership. The nominations shall be considered by the Executive Committee and if approved by each of its members, shall be submitted to a vote of the Academy at any annual or special meeting.

(b) Nominations for Corresponding Members, Honorary Members, and Patrons, shall be made by the Executive Committee of the Academy, the elections to take place as in the case of Resident Members.

2. *Election of Members, etc.* All elections shall be by ballot. To elect a Resident Member, Corresponding Member, Honorary Member, or Patron, shall require the assent of three-fourths of all Resident Members voting.

3. *Expulsion.* Any member may be expelled by a vote of nine-tenths of all members present at any annual meeting, provided notice that such a movement is contemplated, be given to members at least three months previous to such action.

4. *Election of Officers.* Nominations for office shall be made by a nominating committee as provided in the By-Laws. The nominations shall be submitted to a vote of the Academy at its regular annual meeting. The officers thus elected shall enter upon their duties at the adjournment of the meeting.

ARTICLE VI, MEETINGS.

1. *Meeting.* The Annual Meeting shall be held during the Thanksgiving recess, the place being determined by the Executive Committee and announced by circular at least thirty days before the meeting. The details of the daily session of each meeting shall be arranged by the Executive Committee, and announced in the official program immediately before the meeting.

2. *Field Meeting.* A field meeting may be called at the option of the Executive Committee.

3. *Special Meeting.* A special meeting of the Academy may be called by the Executive Committee upon the written request of twenty Resident Members.

4. *Quorum.* Fifteen Resident Members shall constitute a quorum for the transaction of business.

ARTICLE VII, SECTIONS.

1. Members not less than fifteen 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 Geology of The Ohio 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 VIII, AMENDMENTS.

1. This Constitution may be amended at any annual meeting by a three-fourths vote of all Resident Members voting, provided that the substance of the amendment shall have been submitted at a preceding Annual Meeting.

BY-LAWS.

CHAPTER I, MEMBERSHIP.

1. No person shall be accepted as a Resident Member or as Corresponding Member unless dues for the year are paid within three months after notification of election. The annual dues shall be one dollar and fifty cents, payable in advance. A single payment of twenty-five dollars however 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 converted into the Research Fund.

3. Non-payment of annual dues shall deprive a Resident Member of taking part in the management and receiving the publication of the Academy. An arrearage continuing over two years shall be construed as notification of withdrawal. The Secretary, Treasurer, and Librarian shall be exempt from the payment of dues during the year in which they hold office.

4. Any person eligible under Article III of the Constitution may be elected a Patron of the Academy upon payment of one hundred dollars to the Research Fund of the Society.

CHAPTER II, OFFICIALS.

1. The President and the Treasurer shall countersign, if they approve, all duly authorized accounts and orders drawn for the disbursement of money.

2. The Treasurer shall give bonds with two good sureties approved by the Executive Committee in the sum of five hundred dollars, for the performance of his duties and the safe keeping of the funds of the Academy. He may at his discretion deposit the funds in a bank, but shall not invest them without the authority of the Executive Committee. His accounts shall be balanced on the first day of the Annual Meeting of each year.

CHAPTER III, ELECTION OF MEMBERS.

1. Nominations for Resident Members may be proposed at any time on blanks to be supplied by the Secretary.

2. The form for the nomination shall be as follows:

OHIO ACADEMY OF SCIENCE.

To the committee on Membership................190.... I desire to become a member of the Ohio Academy of Science.

Name ....

Address ....

Branches of Science interested in...................................

Countersigned by Members { ....
....

3. This form when filled is to be transmitted to the Secretary who shall bring all nominations before the Executive Com-

mittee at either the Annual, Special or Field meetings of the Academy, and the Executive Committee shall signify its approval or disapproval of each. The list of candidates approved shall then be presented to the Academy for election.

4. Patrons, Honorary Members and Corresponding Members shall be nominated by the Executive Committee and shall be elected in the same manner as Resident Members.

CHAPTER IV, ELECTION OF OFFICERS.

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.

2. The Academy shall select by ballot a Nominating Committee consisting of three members who shall nominate a candidate for each office including elective members of the Executive Committee, the Publication Committee, and the Trustees of the Research Fund. Additional nominations may be made by any member of the Academy.

CHAPTER V, FINANCIAL METHODS.

1. No pecuniary obligation shall be contracted without express sanction of the Academy or the Executive Committee. It is understood however that all ordinary expenses in connection with the meetings have the permanent sanction of the Academy without special action.

2. Every creditor of the Academy must present to the Treasurer an *itemized* bill certified by the official ordering it, and approved by the President. The Treasurer may then approve and 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 who are not officers of the society, to whom shall be referred the books of the Treasurer duly posted and balanced to the first day of the Annual Meeting as specified in Chap. II, Sec. 2, of the By-Laws. These Auditors shall examine the accounts and vouchers of the Treasurer

and before the adjournment of the meeting shall render a report, and the Academy shall take appropriate action.

CHAPTER VI, PUBLICATIONS.

1. The publications of the Academy are in charge of the Publication Committee.

2. One copy of each publication shall be sent to every Resident Member, Corresponding Member, Honorary Member, and Patron, while each author shall receive thirty copies of his memoir. This provision shall not be understood as including publications in journals not controlled by the Academy.

3. The official organ of the Academy is the Ohio Naturalist under the following terms of agreement:

(a) The Academy shall pay to the Ohio Naturalist seventy-five cents for each subscription sent to members not in arrears for payment of dues.

(b) The Ohio Naturalist shall publish announcements of meetings, list of publications for sale, etc., whenever the Academy desires. Such matter however may be restricted to one-half page of advertising space in any one issue.

(c) The Ohio Naturalist will print papers of from 300-1,500 words presented at the annual meeting provided such papers are submitted in type written form within two weeks from the time of adjournment of the meeting, and have been passed upon favorably by the Publication Committee and by the Editor of the Naturalist.

4. The Annual Report of the Academy, including list of officers, list of members, presidential address, and such other matter as the publication committee may determine shall be printed as a separate issue by the publication committee.

5. Papers exceeding 1,500 words may be published at the discretion of the publication committee as a part of the series of Special Papers.

6. The publication committee shall assemble the Annual Report and the Special Papers into volumes of proceedings of convenient size, paged consecutively in each volume, under the general title "Proceedings of the Ohio Academy of Science."

CHAPTER VII, RESEARCH FUND.

1. The Research Fund shall consist of moneys paid by the general public for publications of the Academy, of donations made in the aid of research, and of sums paid in commutation of dues according to By-Laws, Chapter I, Paragraph 1.

2. Donors to this fund, to the sum of twenty-five dollars or more, shall be entitled without charge, to publications subsequently appearing.

3. The aim of the Academy shall be to accumulate a fund of which the income alone shall be used for the encouragement of research and for the publication of papers bearing upon the development of science in the state.

CHAPTER VIII, ORDER OF BUSINESS.

1. The order of business at the Fall Annual Meeting shall be as follows:

1. Opening.
   a Call to order by the Presiding Officer.
   b Statements by the President.
   c Appointment by the chair of a committee of three on membership. To secure nominations of new members.
   d Appointment by the chair of a committee of three on resolutions.

2. Reports of officers.
   a Secretary.
   b Treasurer.
   c Librarian.

3. Appointment by the Academy of an Auditing Committee of two members.

4. Reports of Standing Committees.
   a Executive Committee.
   b Publication Committee.
   c Program Committee.
   d Trustees of Research Fund.

5. Reports of Special Committees.
6. New Business.
7. Election of Nominating Committee.
8. Report of Nominating Committee and Election of Officers.
9. Election of Members.
10. Report of Committee on Resolutions.
11. Report of Auditing Committee.
12. Unfinished Business.
13. Adjournment.

2. Items of business under 1 to 7 shall be taken up at the first business meeting where possible and be followed by reading of papers. At an adjourned session the order shall be resumed at the place reached on the previous adjournment, but new announcements, motions, and resolutions, shall be in order before the resumption of the business pending.

3. At a Special Meeting or a Field Meeting items of business under 2, 3, 4, except "a," 7, 8, 11 shall be omitted.

4. At any Special meeting the order of business shall be 1, followed by the Special or Field Meeting, business for which the meeting was called, and this in turn followed by 9, 12, 13, when advisable.

CHAPTER IX, AMENDMENTS.

These By-Laws may be amended by a majority of those voting at any annual meeting.

L. B. WALTON,
E. L. RICE,
F. L. LANDACRE,
Committee on Revision.

THE RAISED BEACHES OF THE BEREA, CLEVELAND, AND EUCLID SHEETS, OHIO.[1]

FRANK CARNEY.

INTRODUCTION.

A Moravian missionary, Rev. John Heckewelder, came into the Tuscarawas valley, Bolivar county, in 1762. He traveled much throughout the State in his labors with the Indians, and in

[1] Presidential address read before the Ohio Academy of Science at the Granville meeting, November, 1908, representing work carried on under the direction of the Ohio Geological Survey. The author is responsible for the opinions expressed.

1796, drew a map of northeastern Ohio; on this map, he makes the first reference, so far as I can ascertain, to the Lake Erie shore lines. Accompanying the map is a brief description in which he refers more in detail to some of the deposits, now known to be of glacial and lake origin, about the lower part of Cuyahoga river.

In the second annual report of the Geological Survey of Ohio, published in 1838, on p. 55, Col. Charles Whittlesey refers to the beaches skirting Lake Erie. It would indeed be surprising not to find in these early documents references to the lake ridges — they are so conspicuous a feature of the landscape. The Indians selected these ridges for their paths, and the first settlers located their highways and dwellings on them. Colonel Whittlesey's comments are very brief.

The first even casual study of these beaches was by Sir Charles Lyell, the British geologist, in 1842; he followed two of the ridges for much of the distance between the Cuyahoga and Rocky rivers. He suggested methods by which they might be more correctly interpreted, lamenting that he did not have the time to ascertain whether fresh or marine shells were to be found with the gravels. He gave it as his tentative opinion that the "Middle Ridge"[2] (fig. 1) in particular appears to be subaqueous in origin.

In 1870, G. K. Gilbert studied the raised beaches in the Maumee valley; this work is probably the first rigorous study of shore-phenomena associated with ice-front lakes. Gilbert mapped the four beaches which indicated the levels of Lake Maumee and the succeeding bodies of water held up by the Erie lobe. Since his field of investigation was limited to the northwest counties of the State, he did not follow the beaches very far to the east nor to the north. Gilbert's methods of studying these ridges, as well as many of his conclusions, were entirely new to the science of geology; some of his interpretations he himself altered later.

---

[2] The discussion of these beaches can be followed to better advantage if you have at hand the three topographic sheets involved.

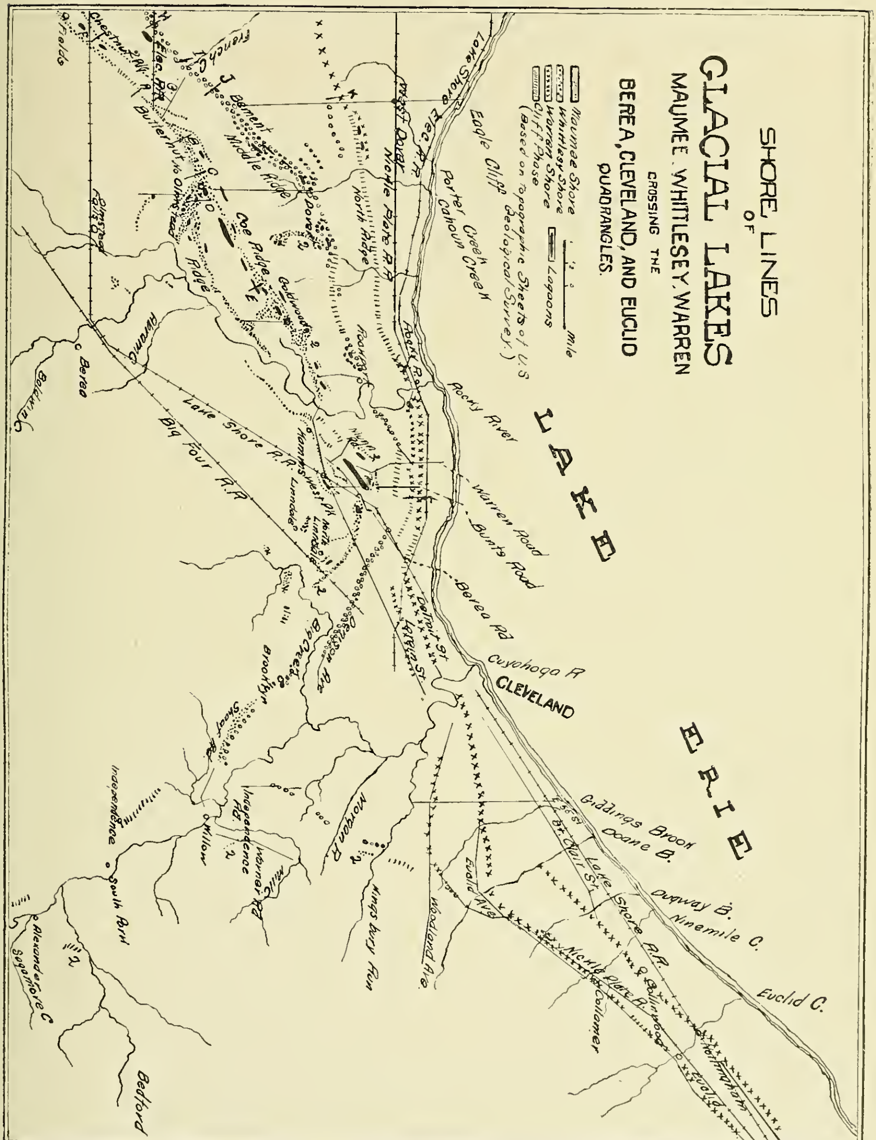

SHORE LINES
OF
GLACIAL LAKES
MAUMEE, WHITTLESEY, WARREN
CROSSING THE
BEREA, CLEVELAND, AND EUCLID
QUADRANGLES.
Maumee Shore
Whittlesey Shore
Warren Shore
Cliff Phase
Lagoons
Mile
(Based on Topographic Sheets of U.S. Geological Survey.)
LAKE
ERIE
CLEVELAND
Cuyahoga R.
Rocky River
Warren Road
Bunts Road
Berea Rd
Detroit St
Lorain St.
Lake Shore R.R.
Big Four R.R.
Nickle Plate R.R.
North Ridge
Middle Ridge
Coe Ridge
Eagle Cliff
Porter Creek
Cahoon Creek
Berea
Giddings Brook
Doane B.
Dugway B.
Ninemile C.
Euclid C.
Euclid Ave
Woodland Ave
Kingsbury Run
Morgan R.
Big Creek
Independence
South Park
Bedford
Collamer
Lake Shore Elec. R.R.
St. Clair St.

FIG. 1.

The same volume which contains Gilbert's map on the beaches of the Maumee lobe, also contains J. S. Newberry's article on the Geology of Cuyahoga County; in this, Newberry devotes about four pages to the lake ridges.

In the succeeding volume of the Ohio Survey, A. A. Wright and J. S. Newberry published a more detailed description of these ridges between Elyria and Cleveland. Each ridge was traced for several miles at intervals; no attempt was made to give a detailed description of any particular beach.

From about 1890, the shore-phenomena of ice-front lakes has been given special attention by many trained geologists, either independent workers, State Survey men, or employees of the Canadian and United States Geological Surveys. The descriptions of, and references to, the beaches in the vicinity of Cleveland are numerous and have involved much labor in their correlation. The actuating purpose of each of these workers was the bearing that the ridges of a particular locality have on broader questions of the greater lakes' history; for this reason, we find very few close studies of any of the beaches.

The present investigation concerns the lake ridges of a narrow area; it attempts no contribution whatever to the larger problem of successive ice-front lakes. One of my purposes is the interpretation of the activities along present water-bodies from the standpoint of work done by water-bodies of the past. The activities of wave and shore currents of the present Lake Erie may be intelligently studied in the light of what these same agencies were doing when the lake was one hundred to two hundred feet deeper. At no place in the State can one find in such horizontal nearness, in more complete development, and in better preservation, the shore lines of former water-bodies.

GENERAL CONSIDERATION OF ICE-FRONT LAKES.

When the great ice-sheet attained its maximum development in North America, east of the Mississippi it extended beyond the divide of the present St. Lawrence drainage basin. This position was not reached by an uninterrupted progress.

From the dispersion centers of Labrador and Keewatin the ice fed outward, sometimes maintaining a stationary front because melting and feeding were balanced, retreating when wastage was the more active, and advancing with the ascendancy of the feeding.

Wherever the great plain over which the ice was spreading sloped away from the ice, drainage moved freely; where, however, this plain sloped toward the coming ice, the water gathered, forming lakes.

The record of the bodies of water marginal to the Wisconsin ice-sheet has long been known with much accuracy. As soon as the ice in its retreat came to a halt within the basins of the present Great Lakes, then frontal water accumulated; thus there were small lakes in the Michigan and in the Erie basins, while the remaining basins were buried beneath ice. These small lakes gradually expanded as the ice-cap diminished. So long as each lake maintained an independent overflow southward, it is evident that there had not been disclosed, in the area between these lakes, an altitude lower than the altitude of the overflow channels. As soon as any lower point was disclosed by the retreating ice then the marginal lakes coalesced and continued to drain southward by the lowest col reached. Frequently long intervals of time marked the spacing of these periods of retreat. It is this fact that makes it possible today to deliminate the extent of these temporary lakes. A time did come, however, when the whole front of the gradually receding ice-sheet was skirted by a body of water which reached the ocean by a single overflow channel. The first of these more expanded bodies of water overflowed by way of the Illinois river, past the present location of Chicago. A lower outlet was revealed when the ice withdrew from the Mohawk Valley area; then this great marginal lake reached the Atlantic by the eastern outlet.

The succession of ice-front lakes, as we today read descriptions of their succeeding overflow channels, include so many positions that we fail to comprehend the time involved. We feel that the shore line of any particular one of the present Great Lakes, as Superior, represents a long time period. We have difficulty, perhaps, in realizing that Lake Whittlesey, or Maumee, probably endured quite as long as the present Lake Ontario. When, however, we compare the rock cliffs now bordering the shore of Lake Erie, the constructed beaches, the barriers, the lagoons isolated by development of new bars, the dune sands reaching inland from the shores, with the identical phenomena of these lakes of the past and see how little they differ in scale, in spite of the denuding agencies that have operated upon them since they were formed, then we can better comprehend the very appreciable time intervals represented by the successive stages in the past history of the Great Lakes.

The shore of Lake Maumee in the vicinity of Cleveland was irregular because of the embayments occupying the Rocky river and Cuyahoga river valleys. The arm of the lake extending southward into the former valley was crescent shaped, the western being the shorter of the two segments; but the prevailing winds, by constructing spits and bars, gradually brought that part of the shore into alignment with the general direction of the beach. A more detailed discussion of this is given later.

The valley of Big Creek also formed a small bay during the early part of this lake stage; here again, on its western side, bars gradually developed and straightened the shore line.

The mature Cuyahoga valley was occupied by water of the Maumee level, reaching southward through the entire length of the Cleveland sheet. This arm was the drowned portion of the Cuyahoga valley, for the tributaries of which the lake constituted a local base level into which they spread deltas.

The shore of the Lake Whittlesey stage shows no evidence of a bay in the meridian of Rocky river; there was a slight curve in its outline where the water fronted the lower part of Big creek. In the Cuyahoga valley, however, this stage extended southward through the Cleveland sheets; its altitude is recorded by terraces cut into the deltas of the preceding stage, as well as by the extension of these deltas during the existence of Lake Whittlesey.

The Warren shoreline is characterized by but one embayment, that occupying the Cuyahoga valley which was ponded the entire length of the Cleveland sheet.

THE DEVELOPMENT OF SHORE LINES.

The processes involved in the development of shore lines are chemical and mechanical. The chemical factor is not of great consequence, though from one point of view it demands attention; the mechanical processes are really the ones that need consideration. Winds impel the water into waves and currents producing primarily two movements, on-shore and along-shore. The effectiveness of each movement is controlled directly by the velocity of the wind and the nature of the coast.

The work accomplished by these agencies is influenced in the first place by the nature of the material which the waves are attacking; if the coast is rock it yields less readily than do unconsolidated deposits; in the second place, by the profile of the beach and off-shore slope. Ultimately these agencies under normal exposure to waves will bring about a fairly uniform and constant profile which is a gentle long slope into deeper water. The time required for a given body of water in a particular locality to produce shore line structures, depends very largely upon the original outline of the coast: if sufficiently irregular, and if it yields quickly to these denuding agencies, a supply of material will be at hand for constant work.

It is in the production of this material that the chemical process figures. In the presence of water, chemical disintegration is facilitated. This is important even when the coast being attacked consists of unconsolidated deposits. The basic elements of glacial drift break down more readily, leaving the acidic for distribution by waves.

But the more effective work in the preparation of material is accomplished locally by the waves of translation which erode the shores producing bluffs, that in turn are under-cut by wave-impact and the tools the water has in it. This on-shore movement of water likewise grinds the constituents of the beach, rounding and diminishing the size of all the stones. The along-shore movements also do much attrition work. Furthermore, as the waves of greater size break off-shore, they pick up bits of rock, dashing them again to the bottom, thus continuing the work of attrition begun nearer shore.

All this material is being distributed likewise by the water. Beach ridges represent the ascendency of the work of water moving on-shore over that accomplished by the water moving outward, that is, the under-tow. Whenever the dash of oncoming waves drives material up the slope beyond the effective reach of the under-tow, that material becomes part of the beach ridge. The ridges represent the work of unusually strong and more directly on-shore movements; an equally powerful on-shore wave, striking the coast obliquely, is not so effective in constructing ridges. Since the beach ridge, then, represents a differential of these quite opposing movements of water, it follows that the shape of this ridge is also the result of this difference. The undertow cannot carry any save the smaller bits of rock, and only the finer portions are carried very far off-shore. Material in suspension is always the finest product of destructive work and will be taken farthest from the shore line. The front slope of a beach ridge has a long gentle gradient, save at the edge of the water, where, for a short horizontal distance, the angle is sharper; the back-slope often has a short, sharp angle, and stands more conspicuously above the coast (figs. 2, 3).

When the waves do not strike the shore directly, the oblique movement sets up an along-shore drift; this along-shore drift is a more active distributing agent when the coast is parallel to, or but slightly transverse to, the direction of the prevailing winds. The outlines of these high-level lakes were in general concentric with the present Lake Erie, the shore of which is well exposed to the sweep of the prevailing west winds. It is due to this relationship that headlands have been removed and their products distributed to the east.

Where an angle of water extends into the land, we generally find a *spit* gradually growing out across this reëntrant from its windward side. The along-shore movement of water distributes material in a straight line unless some stronger force tends to deflect the line of deposition. Such a deflecting force is present when we find translatory waves passing landward through the deepening area of the bay; then the spit is bent inward in the shape of a hook. As the height of the spit increases from its tied end, the effectiveness of this deflecting movement is tempered, and we see in consequence, that the spit continues its development in a straight line, leaving the hooked portion as an irregularity on the back slope of the spit; when the bay has been completely shut off, this constructed form is called a *bar.* It not infrequently happens that spits are developed outward from either side of a bay, sometimes uniting, and sometimes passing each other, thus isolating the bay.

In the construction of spits from the windward angle of the bay, sometimes intervening areas are isolated and form lagoons. These lagoons may be developed in series, as when the spit terminates in a hook and later continues to grow forward; more often, however, the lagoons have long axes parallel with the trend of the bars.

Through the interference of shore currents, such interferences often arising from deflected movements of water, the loose materials instead of being carried continuously parallel with the shore, are so deposited as to form a cape which gradually grows out into the water. This constructional form is termed a *cusp.*

When the shores slopes gradually into deeper water, the higher waves break some distance from the shore; the work then done is similar to that accomplished by strong waves breaking at the water-margin, that is, material is piled up; this piling up of detritus in deeper water develops a *barrier* which is, in reality, a submerged beach ridge; barriers therefore, are parallel to the shore. Much of the material which enters into the construction of barriers has been carried back from the shore by the undertow. In time the barrier grows higher, and accordingly interferes with the velocity of along-shore currents, causing the water to drop some of the load it may be carrying. From this time on, the barrier grows through these two methods; it may ultimately rise to the surface of the water and eventually form the shore line proper; when this happens, the space between the beach ridge or cliff and the barrier becomes a lagoon.

We sometimes find a cusp fringed by a barrier; the process of its development is identical with the method above discussed. Between this barrier and the cusp, a lagoon may appear. The barrier may or may not border the entire cusp.

Islands, and shallow places due to irregularities of the lake bed, interfere with the movements of the water; the former undergo wave and current erosion, thus supplying materials for the construction of spits, etc.; the latter, when rising sufficiently near to the surface of the water, may check its velocity and thus grow upward through the accession of deposits. With the continuation of this process, an island may appear, and from it spits will develop with the course of the prevailing winds.

LAKE MAUMEE LEVEL.

I will describe these beaches from west to east across the Cleveland area (fig 1). The altitude usually assigned to the Maumee level ranges from 765 to 785 feet. This lake was about 200 feet deeper than Lake Erie. Two stages are indicated by a higher and lower beach varying 15 to 20 feet in altitude.

From Fields east to the Elyria traction line this shore consists of a cliff and terrace cut in the glacial drift (fig. 2, A); the terrace bears some gravel; thence to the vicinity of Kamms, which is just east of the Rocky river, it is made of gravel and sand. In places this beach has a steep back-slope; throughout most of the distance, the front slope rises from 15 to 20 feet (fig. 2, B, C, D). Southeast from North Olmsted its constituents are fine to coarse sand, and less gravel. For a long period the region about North Olmsted must have formed a point or cape in the shore line as it marked the western limit of the Rocky river embayment. There is evidence of vigorous wave-action here; a few rods south of the corners at North Olmsted is a gravel ridge with a front-slope 3 feet and a back-slope 7 feet high, and containing stones as large as 3 inches in diameter.

The first barrier built in this embayment is traversed by a south-east-trending road connecting the two north-south highways south-east of North Olmsted; this barrier is about three-fourths of a mile long and consists chiefly of fine deposits. Its discontinuance westward where we would normally expect it to join the main ridge may be partly due to removal by erosion;

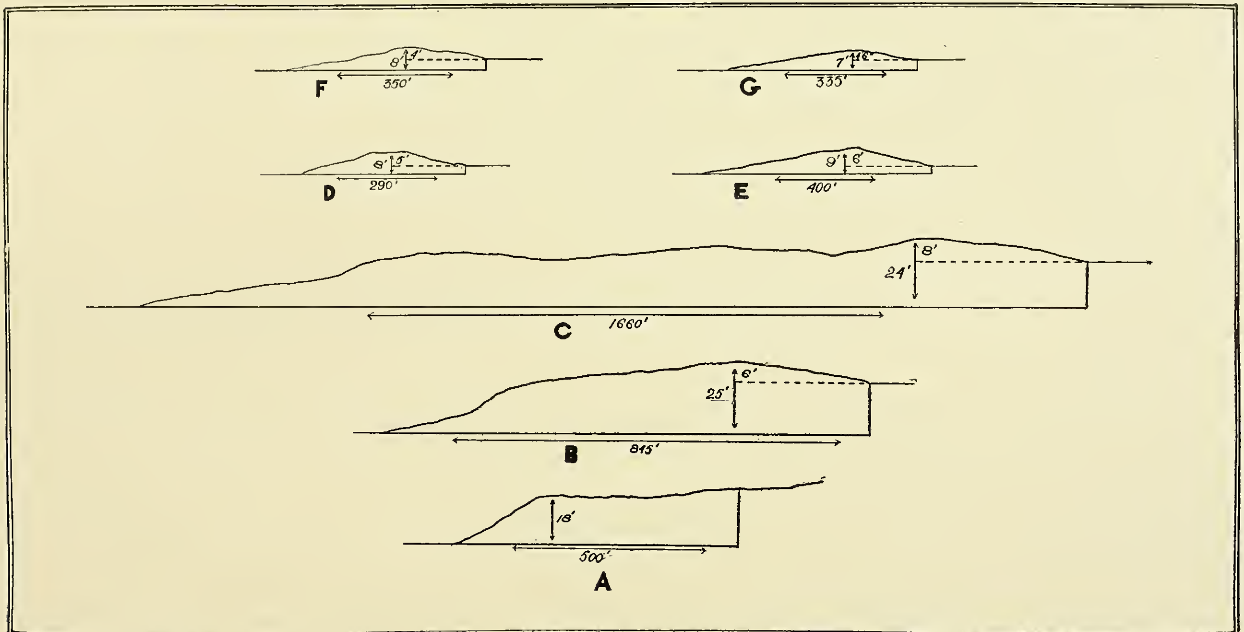


Fig. 2. Cross-sections A-D belong to the upper Maumee level; E-G, to the lower Maumee level. The location of the cross-sections may be found on fig. 1.

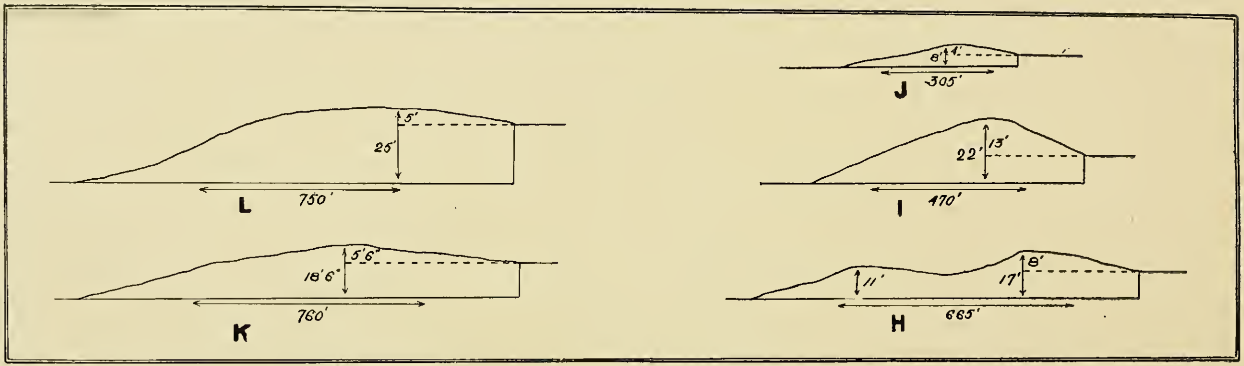


FIG. 3. Cross-sections H-J belong to the Whittlesey level; K and L, to the Warren level. For location of each cross-section consult fig. 1.

eastward it flattens out and disappears within about one-fourth mile of the Rocky river channel. Inland from this I found no evidence of a beach, a condition due to the very low gradient and the consequent wide zone of shallow water. About one-half mile north of the west end of this barrier there is another ridge, terminating near the creek in a slightly recurved spit, apparently subaqueous in origin but later marking the shore line for a relatively brief period, after which it was gradually isolated by the development from the western shoulder of the embayment of still another spit.

The road extending southeast from North Olmsted traverses this bar which tended further to shut out the Rocky river embayment; this bar is coarser in texture than the bar above described, and encloses in its rear several lagoons which were developed consecutively from west to east by the hooked growth of spits as the bar extended farther across the bay. This ridge continues to the edge of the present channel of Rocky river, and there is some evidence of it eastward from the river.

Returning to the shoulder in the main shore line at North Olmsted, we find at the present time a pronounced cliff, swinging at first slightly to the south and then continuing directly east. Between this and the bar last described, there are several marsh areas or lagoons, decreasing in number and size eastward, and each representing an inward bend or temporary hook-terminus of the spit. While this originated as a spit growing into the bay, it came in time to be a typical wave-constructed beach; its front slope is gentle, rising in altitude from 10 to 14 feet; the back slope is nowhere very pronounced, owing to the leveling-up of the lagoon depressions. The beach averages about 10 rods in width; in places, however, the back slope is so slight as to make exact measurement impossible. Over the first mile of this beach, a highway extends, branching at the river into one road running directly north and another skirting the river channel; this latter road continues on a slight gravel ridge, the most pronounced phase of which lies to the east of the highway next to the river cliff. It is probable, however, that the complete development of the shore-ridge in this locality may not now appear for the reason that on its eastern side the river has undercut much of its width. After the first half mile, the beach lies entirely to the east of a highway, at which place it has been worked for a long time as a gravel pit; this is on the farm of W. F. Schultz. Proceeding, the highway again strikes the ridge which at no point for the next mile rises more than 5 feet above the general level; it discontinues within the next one-half mile, terminating directly southeast of Goldwood; but on the opposite side of the river about one-half mile south of Puritas Springs, we find this beach again, and can follow it without a break to within one-eighth of a mile of Kamms, where it becomes a cliff, cut in the Cleveland shale. A few rods east of Kamms, the cliff phase changes to a low gravel ridge which continues through and east of West Park.

In the vicinity of West Park the water deepened so gradually to the north, that no beach ridge was constructed; low spits, however, were developed, apparently of the barrier-type in origin, which were later somewhat modified as the on-shore waves succeeded in forming a true beach. One such spit turns sharply northward of the intersection of Lorain and Davisville streets. This relationship of ridges accounts for the slight lagoon just southeast of the corner at West Park. Other lagoon areas were developed within a mile north of this area, the principal one of which lies between the Berea and Warren roads; apparently, this latter lagoon represents a slight bay which was later enclosed by a barrier.

The West Park area presents some complexities in shore structure largely because of its proximity to the Big Creek embayment. This embayment was in time completely shut off through the successive growth of bars.

The first of these spits ties to the main shore in the vicinity of Linndale, extending north-westward about one-quarter of a mile; this has a pronounced development, being from 5 to 15 feet in altitude; it consists of well worn gravel and sand. No spit correlating with this was found on the opposite side of the bay.

Extending southward from Lorain street, is another spit from 2 to 5 feet in altitude, and for about one-half mile continues a few rods west of Bosworth road, after which this road follows the ridge to Bellaire road, in North Linndale. The western tributary of Big creek runs parallel with this spit for about 80 rods.

Some scattered ridges of gravel exist south of Big creek on the opposite shore of this embayment.

After the Maumee lake level had finally established a continuous shore line across the valley of Big creek, the beach-forming agencies must have worked uninterruptedly for a long period. From the intersection of the Big Four track with the Berea road northeast of Rockport, eastward to the present channel of Big creek in the vicinity of the West Shore railroad, the shore is a beach-ridge and cliff averaging about 23 feet in height and having a sharp front slope. In the northwest part of Rockport village are depressions representing a lagoon developed in the growth of this beach, but eastward to the West Shore railroad, the ridge, simple in construction, consists of ordinary shore gravels. At the West Shore railroad, however, it divides; one of these divisions terminates on the edge of the creek bluff, but probably reappears again in a slight gravel ridge overlying moraine, south of the creek; the other arm, later in development, trends southeast, terminating in the bluff near West Park cemetery.

For the next one-half mile, I was unable to find any gravels, but the shore line appears to be indicated by a cliff cut in the moraine; nearing Brooklyn, however, beach gravels again appear. Street grading and other structural work have so modified topography here that one can not decide whether the ridge through a part of Brooklyn is of barrier origin, or of regular beach construction. South of Brooklyn, as the Schaaf road diverges to the east, the Maumee level is plainly marked; the highest part of the beach here bears much sand, suggesting subaqueous origin.

East from this point the higher Maumee level is not definitely marked. North of Independence, the slope has been steepened possibly by wave-work, and possibly by stream-work when the glacier extended southward into the Cuyahoga valley, ponding the drainage which escaped westward along the edge of the ice. About a mile north of Willow along the Warren road, there is beach gravel, and north of Kingsbury run the rock slope appears to be wave-cut at an altitude correlating with this lake stage.

Returning to the western edge of the Berea sheet, we find a few rods north of this shore line what was probably a barrier, and later a beach, followed now by a highway, locally designated "Chestnut ridge." This ridge is about 15 feet below the shore line above described; it consists generally of fine sand; is from 4 to 6 rods wide and rises 8 feet on the average along its front-slope, which is very gradual (fig. 2, F, G). Between Chestnut ridge and the beach of the higher Maumee level, the interval is very mucky, indicating a former lagoon condition; to the east and north, this ridge blends gradually into the general level. Between this point and North Olmsted, two slender ridges, tied at their western ends to the beach of the higher level, trend with the old shore line.

From North Olmsted to the edge of the present river channel directly west of Kamms, is a sharply defined beach slope changing locally into a constructed shore ridge. Throughout this distance we have the permanent shore line for the lower Maumee level (indicated by 2 on fig. 1), marking the position of the water after the Rocky river embayment had been completely closed; the back slope of the ridge descends into extensive mucky areas which indicate the swampy condition that prevailed for a long period after the embayment had been shut off. Market-gardening is the chief industry in this section at the present time. The most conspicuous spit developed in the process of enclosing the Rocky river embayment is the broad-based ridge extending southward from Goldwood; opposite the end of this, extending northwestward from the other shore of the bay, is a correlating spit; apparently the two approached quite closely but have since been separated by erosion.

Proceeding eastward from Goldwood this shore line takes on more and more the form of a constructed beach, varying in width from 4 to 15 rods, and in height from 12 to 24 feet. Near the river it is slightly modified through erosion.

Another feature of this level of the Maumee stage is found in the off-shore bars which are not strictly of the barrier type. The second highway east of North Olmsted, running to the north, passes along a north-south ridge of gravel and sand. Reaching eastward from the termini of this ridge are compound spits that represent the work of west winds. This bar and its appended spits with their like orientation indicate a shallow place in the water occasioned probably by a ridge of glacial drift. Smooth-surfaced till, rather stony in texture, is found in the fields east and west of this ridge. Wells sunk in the ridge also penetrate drift, but throughout its whole extent the ridge is covered with gravel from 5 to 14 feet in thickness. The spits that have grown from the ends of this ridge present several interesting features, especially in their constant trend to the east, in their gradual variation in texture from coarser gravels to fine sand eastward, and in the lagoons formed by the development of secondary spits from the windward side of the angle made by the main bar and the spit already developed.

A short one-half mile northeast of Goldwood is a cusp fringed by a barrier. The cusp is about 50 rods long; between it and the barrier is a lagoon.

Eastward towards the river, just before crossing the road which leads north to Rockport, is a short barrier with a lagoon in its rear. From the intersection of the Rockport road with the main shore, another ridge extends north-eastward; this, throughout nearly the whole of its one-half mile length, shows a strong development, in places 4 to 6 rods wide on top; and having a sharp back-slope.

Continuing eastward along this lower level of the Maumee Lake, we find on the opposite side of the river, west and north of the Rockport race track, a short slope due to wave work on the shales thus forming a cliff. For some distance this shore line is indistinct, but reappears about one-half mile northeast of Munn road, in a strongly developed gravel ridge which swings due east after crossing Warren road. It shortly blends into a low ridge of clay. The interpretation of this clay ridge was puzzling for some time; it is plainly not of glacial origin, and is so free from gravel or other normal wave-worn products that a shore line genesis did not suggest itself. In this vicinity, the Cleveland shale bears scarcely a veneer of glacial deposits. Wave action in consequence has attacked the shale, and because of the very low slope of the lake basin, cliff cutting did not take place. The shale was ground off by the waves and piled in a low ridge, so slowly that weathering proceeded, it is thought, to a considerable extent before Maumee Lake fell to a lower level.

Going south from Warren road, along Brown road, one crosses two other slight gravel and sand ridges which alternate with lagoons. The southernmost of these formed the north shore line of the lagoon bay, already mentioned, which Brown road crosses before reaching Berea road.

Farther eastward, I have not noted any distinct shore-ridges correlating with this second Maumee level, except the possibility of such a ridge being indicated by the shore gravel extending south-eastward from the intersection of this beach with the West Shore railroad just north of Big creek. The front-slope of the beach along Schaaf road shows some evidence of being modified by the water of this lower level. The Tinkers creek delta has a cliff and terrace which apparently correlates with it. Northeast of Willow, on the slope east of a brick plant, are gravels at the proper altitude. And east of 87th street, between Union avenue and Kinsman road, is another area of possible lower Maumee shore deposits.

LAKE WHITTLESEY LEVEL.

The altitude of this shore line is approximately 735 feet, or about 30 feet lower than the preceding stage. From the western border of the Berea quadrangle to the Cuyahoga river, it is practically unbroken, and for the major part of this distance consists of a gravel ridge, in a few places one-quarter of a mile wide, enclosing lagoons. The Cleveland, Elyria, and Western Electric railway enters the Berea sheet on this ridge, but after traversing it for a few rods, swings directly eastward to the shore ridge of the Maumee level.

Cross sections of the western part of this beach are shown in fig. 3, H-J. The compound characteristic of the ridge is apparent in section H. The low front-slope condition here indicated continues to characterize the ridge north-eastward as far as Bement; from Bement to Dover, the ridge is found in its most complex phase; through most of this distance, the outer slope is longer than shown in section J. The ridge top is much broader and for the second half of the distance we find a series of ridges alternating with longitudinal muck basins.

FIG. 4. Looking eastward along the Whittlesey beach one-half mile east of Dover.

From Dover eastward to Rockport the ridge consists of gravel with a short front-slope rising 20 to 22 feet, and a back-slope dropping not more than 7 feet (fig. 4). The compound form of the ridge observed west of Dover is much less characteristic of this portion; nearing Rockport, however, I have noted a few former swamp areas. The shape of the front-slope for several miles here indicates cliff-development, at the western portion in shale, and eastward, where the shore line crosses the buried Rocky river channel, in drift.

Crossing the Rocky river, the course of this beach is indicated for about one mile by Hilliard road, but at the intersection of West Madison avenue, the beach swings directly to the east, and changes from a gravel ridge to a cut cliff shown in the steep slope just north of this avenue. From Ridgewood avenue, eastward to the Lake Shore railway, the course of the beach is not definite; but upon crossing the Lake Shore, it comes in once more in its beach-ridge phase and thus continues to the neighborhood of the intersection of Fulton road and Denison avenue. From Lorain street almost to Fulton road, this ridge originated as a spit developing into the Cuyahoga embayment, and for over one-half of the distance, for some period of time, appears to have formed the shore while the other half apparently was still subaqueous.

From Fulton road to the western part of Brooklyn, whatever development this beach had obtained has since been obliterated by the erosion-work of Big creek. Its course through Brooklyn is somewhat doubtful because of street grading and other destructive work. The best exposure of the beach-ridge in this vicinity is along the west side of Broadview avenue just east of West 25th street; for about 80 rods the beach thus continues; it then swings southward across Broadview and flattens out. A short distance farther to the south I noted a wave-cut cliff parallel to Scarsdale avenue, which turns southward crossing Roanoke and Tate avenues. Beyond this point the shore of Lake Whittlesey was at first parallel to, and later coincided with, the lower beach of Lake Maumee. This horizontal coincidence has given the lower Maumee beach a steep front-slope, the difference in the level of the two lakes measuring the vertical distance through which the older beach may have been over-steepened. On the opposite side of the Cuyahoga river, about one and one-half miles north of Willow, we find parallel with Independence road, a bar one-half mile in length; the southern part of this is nearly north-south in direction, but the northern half swings eastward in conformation with the outlines of the Cuyahoga embayment. Sand and gravel of contemporaneous development were noted along 59th street, south of Harvard avenue. For some distance northward this beach could not be definitely mapped since this interval has been worked over in the street development of Newburg, but for a short distance between 80th street and the Pennsylvania railroad, there is a low ridge of gravel conforming in altitude with this lake level. For over a mile to the northward, I have not mapped any gravel or sand interpreted as representing Lake Whittlesey, but just south of the Fairmount reservoir, and parallel to Baldwin street, there is a low sandy ridge which indicates this shore.

From this point eastward I was unable to satisfy myself that the rock escarpment gives any evidence of wave work that definitely indicates the Whittlesey level; there are scattered salients which bear indefinite notches that may possibly indicate cliff-cutting of this shore; some of these benches may also be explained as the result of differential weathering. It seems preferable to state that the rock cliff which continues north-eastward from Garfield's monument for some eight miles is due to denuding agents in operation long prior to the ice invasion, and has since been altered slightly by the wave work of both the Maumee and Whittlesey levels.

LAKE WARREN LEVEL.

Lake Warren marks a vertical subsidence of the Whittlesey level; the drop is about 50 feet. The evidence west of Rocky River on the Berea sheet suggests that the subsidence was brought about in a very short time, but eastward from Rocky river there is an intermediate beach of slight development suggesting a gradual subsidence of the Whittlesey to the Warren level. This intermediate stage averages 20 feet above the Warren beach proper. From the Rocky river, to Ridgewood avenue, it is practically parallel to Detroit street, and consists of a low broad ridge of fine sand and gravel as far as Arthur avenue, while eastward the level is marked by a cliff cut in the Cleveland shale. The same ridge appears again along West Madison avenue, in the vicinity of 81st street; turning to the northeast, it crosses the Nickel Plate railroad, thence more directly east it crosses West 25th street, a short distance south of Lorain street. On the east side of the Cuyahoga the general direction of this beach is indicated by Woodland avenue, which follows the ridge for over two miles.

Just west of the Berea sheet in Lorain county, the Warren shore bears sharply to the north. This point of land extending into the lake acted as a wind break to the shore directly east. In consequence of this, the first two miles of the Warren shore on the Berea sheet consists almost entirely of sand and very fine gravel; the beach contains a slight terrace (fig. 3, K), a cliff that averages about 20 feet, and for the most of this distance, is a low ridge. A few rods east of the north-south road connecting West Dover and Bement, the Warren level is marked by a cliff cut in

FIG. 5. Looking eastward across the Warren shore line at first highway south of West Dover; the cliff is here cut in shale.

the shales (fig. 5), and this phase continues eastward for a little more than four miles. Contemporaneously with the development of the first mile of this cliff, off-shore deposits gradually widened the beach; throughout part of this distance, two or more barriers developed, giving rise to intervening depressed areas where marshes have persisted till the present time. A cliff and terrace characterizes this shore where it crosses the buried Rocky river.

Between the sandy beach on the west side of the sheet and the till terrace marking the site of old Rocky river, the interval of shales bears locally a few feet of glacial drift. Eastward of

Cahoun creek, there is slight evidence of gravel accumulations at the base of the bluff.

Commencing three-fourths of a mile west of Rocky river, the top of the bluff bears a beach ridge, its crest rising three to four feet. Nearing the river, the ridge becomes composite, inclosing lagoons. Directly east of Rocky river, a cusp, developed from this beach, extends northward from Detroit street across the Nickel Plate railroad. For about two miles this beach consists of a sand ridge locally composite, and from 40 to 80 rods in width. Near Highland avenue, the beach gravels present a sharper front slope (fig. 3, L). Just east of this avenue, the shore line swings slightly southward, changing to a cliff cut in the Cleveland shales. In the vicinity of West 100th street, the Warren level is again indicated by a wide sandy beach, in places, reaching from Detroit avenue southward to Franklin avenue.

On the east side of the Cuyahoga, excepting about one mile west of Wade Park, the Warren level is marked by the Euclid avenue beach. From the vicinity of East 65th street, to the campus of the Women's College of Western Reserve University, the Warren shore is found north of Euclid avenue. Eastward as far as Collamer, a beach-ridge condition continues to the eastern edge of Euclid sheet. There is evidence that the Warren level did some wave-cutting in the shales, developing a gravel-bordered terrace that is wider in some places than in others, the control being a matter of stratigraphy. East of Euclid, the cliff-cutting work of this lake was more pronounced.

In the vicinity of the intersection of Ansel road and Superior avenue, I noted a conspicuous development of rather fine sand. Sand of the same level may exist westward, but on account of extensive building operations, tracing it was not at all satisfactory. Eastward from Doan creek, however, this broad, low ridge of sand may be followed without a break to the intersection of Penobscot and St. Clair avenues; from this point eastward, St. Clair avenue is located on this ridge of sand and gravel, and continues thereon to Nottingham. For three-fourths of a mile east of Nottingham, the gravel ridge is but slightly developed, but reappears again just before St. Clair avenue crosses the

Lake Shore tracks; thence for one and one-fourth miles the gravel ridge swings a little north of the avenue and continues to the edge of the Euclid sheet. From Nottingham eastward, this ridge is not over three feet high, even where it is best developed, but west of Nottingham, the ridge in places is 5 feet to 10 feet high, and contains some rather coarse gravel.

This St. Clair avenue beach ridge is about 30 feet lower than the proper Warren level; its shape and continuity suggest a lake stage. West of the river nearly to Edgewater Park there is much sand and fine gravel at the same altitude. If, however, Lake Warren declined slowly, or by short stages, it is probable that the St. Clair ridge is only a barrier beach.

LIFE RELATIONS OF THESE SHORE LINES.

The flat region bordering Lake Erie has been likened to a coastal plain. There are several reasons for seeing a similarity. In the first place, the escarpment due largely to inequality of rock texture serves as a border for the low smooth strip that belts the lake. This flat bordering strip, as we have seen, is a terraced lake plain. Furthermore, the successive lake-stages have given the streams corresponding local base-levels, hence they have had a drainage history very unlike that of coastal plain streams. Organisms, flora and fauna, have been influenced by this particular physiography with its stretches of gravel ridges, rock cliffs, wide strips of sand and marshes, and extensive clay areas. And man, both Indian and white, dwelling here, has also experienced physiographic reactions. It is our purpose to look briefly into some of man's responses.

These old shore lines in their development witnessed the usual shifting facies of plant habitats, developing societies, and in time families and communities, working out the usual history that always takes place slowly under a changing environment. The ecology of modern shore lines under like climatic conditions must be very similar. Each stage of these high level lakes involved a great lapse of time. Some indications of this time are seen in the numerous swamp areas, many of which had not been eliminated by natural processes when the white man came into the area.

As soon as a given level of the lake gave way to a new and lower level, the deserted beach, as well as the area recently covered by deep water, were spread over by plants in their normal struggle. From the standpoint of the farmer, the plant history of this land is of importance. Residual rock alone does not make a fertile farm. He ploughs the soil which is reduced rock plus the remains of organisms; usually the more of this latter addition the better is his soil. A ridge inhospitable to plants is made artificially hospitable to crops only with the greatest of labor.

Beach societies were never prolific, for here flora always has a struggle and even after the withdrawal of the water insuring a static condition of the beach, the plant societies multiplied very slowly. For this reason humus accumulated slowly. Relatively, then, beaches were never fertile. The sand areas always associated with beaches, either through the development of spits, cusps, or deltas, have a more abundant flora, in consequence of which they have become richer for cultivation. The prolific plant life of lagoons develops an almost ideal soil. Many lagoons are found about the angles of embayments and between barriers and shores; these make rich lands.

Another relation of these shore lines, passive but of importance in the development of the region, is seen in their use by the Indian for trails and the white man for highways. In consequence of this influence, the farms front the shore-ridges, and the houses, in general, are placed on the front-slope where quick and effective drainage is best assured. The shape of the older farms, longer or shorter as the shores converge or diverge, again shows an influence of these successive lake levels.

Furthermore, there is observed in the agricultural evolution of this region a tardy adaptation to natural conditions. The first farmers here were emigrants from New England and carried on general farming, extensive in its application. Land was cheap and there was plenty of it; population was sparse, hence markets were limited. Only the old staple lines of grains and fruits were cultivated. Even in a generation, the descendants of these New England emigrants learned that the muck lands associated with the ridges were especially adapted to the growth of onions; further than this, I have not been able to learn of much ingenuity on the part of these aboriginal farmers. Gradually as more distant outlets were found, the first through the construction of good stage roads, later through the digging of canals and the stimulated lake navigation, and finally through the building of railroads, agriculture became more varied.

More thought was given to adapting crops to the soil. The broad flats below the Whittlesey level were found better suited to the growth of vineyards; the soil here is clay, for the most part either glacial or residual of the old shales. We note in this region at the present time further diversity, particularly where a low swell of gravel breaks the usual clay; these slight ridges may be located, usually by an apple orchard three or four rows of trees wide, but awkwardly long.

With the increasing city population, a growth made up very largely of foreigners attracted by opportunities of labor, there came increasing local demands; but the local farmer was tardy in responding to this demand; he was not so thrifty that he regarded his farm investment as a good one; in consequence, the provident foreigner from his days' labor relentlessly saved and so became a farmer. With this gradual supplanting of the New England farmer by the Danes, Germans, Bohemians, and Polanders, came the installation of European thoroughness in agriculture. Intensive and specialized farming rather than the former extensive method was inaugurated as these men became land owners. Farms that had been barely supplying the expenses of living for a Yankee family later formed the basis of permanent bank accounts. The beach ridges were enriched, crops adapted to them were grown; the sandy fields were so treated as to be made more dependable in times of drought; stubborn clay areas were drained and lightened. As the city of Cleveland continued to grow in population, market-gardening in the hands of these foreigners was made very profitable. These new emigrants from old Europe brought with them a training acquired through generations of ancestors engaged in a struggle for momentary support. This training has made them more valuable as American farmers than as laborers in factories.

In still another direction, we find the lake ridges entering into life relations. For industrial purposes, such as building-blocks and concrete, they furnish a supply of gravel and sand; the extensive deposits of lake and glacial clays have afforded material for brick and tile.

We find a specially interesting physiographic reaction in the influence of the lake-made physiography on railroad construction. In this area, the Cuyahoga was the largest river tributary to these lakes. Into the lake at all stages, the Cuyahoga built an extensive delta and as the lakes dropped from one stage to another, tributary streams have incised this delta which is made up of sand, coarse and fine, and gravels of varying texture. It yields readily to stream work, consequently deep channels were developed. Its lack of stability near the walls of a stream is obvious; for this reason railroads have always hesitated about constructing high bridges.

All railroads centering at Cleveland have either east-west courses bordering the lake, or north-south courses paralleling the Cuyahoga valley. The Lake Shore, as the name implies, belongs to the former class. One other east-west road, however, the Nickel Plate, approaching the city from the east, turns southward near the south side of the delta and descends through the valley of Kingsbury run to the level of the present Cuyahoga river in ascending from which, on the western side, it uses another tributary valley. The Big Four uses this same valley west of the Cuyahoga.

The railroads from the south, that is, the Baltimore & Ohio, Pennsylvania, Wheeling and Lake Erie, with the exception of the Pennsylvania, enter the city through tributary valleys cut in the old delta. The Pennsylvania, however, follows Mill creek to Newburg, then it skirts the Maumee beach for two miles and gradually descends the delta slope to the lake front; the Baltimore & Ohio has a more uniform gradient as it follows the edge of the river channel.

But at the present time, a high level bridge is under construction; this is being built across the Cuyahoga on the delta-top level; it is a part of the recently located "Belt Line" which has become the property of the Lake Shore Railroad Company. From the standpoint of engineering, this is a hazardous venture, a fact which in the light of thousands of dollars spent by this company in the last year, much of which has been sunk in the slumping quicksands of this old delta, needs no further comment.

A vital question today in every large American city is speedy transportation for the urban part of its citizens. This fact has led to the construction, in many large centers of population, of subways. For the most part subways in the city of Cleveland would have to be cut through this old delta. Such an undertaking will doubtless present new questions to subway engineers.

This particular part of the southern shore of Lake Erie, if one can clearly interpret the present movement of industry, is destined to be the most thickly populated portion of Ohio. The lake plain here, so far as the city of Cleveland is concerned, even now is too narrow. It is probable that in this assured development many physiographic reactions, new to this region, will arise. This whole composite of conditions, then, is the result of a pre-glacial physiography upon which has been imposed the work of three lake levels, and which is becoming still further complicated by the shore line now in the making.

BIBLIOGRAPHY.

Gilbert, G. K.

"Surface Geology of the Maumee Valley," *Geol. Surv. Ohio*, vol. i (1873), pp. 537-56.

Heckewelder, John

Map of Northeastern Ohio, *Western Reserve Historical Society*, Tract 64 (1884).

Leverett, Frank

"Correlation of Moraines with Beaches on the Border of Lake Erie," *The American Geologist*, vol. xxi (1898), pp. 195-99. *Monograph*, xli (1902), U. S. Geol. Surv., "Cleveland Moraine," pp. 619-51; "The Glacial Lake Maumee," pp. 732-35; "The Glacial Lake Whittlesey," pp. 752-55; "The Glacial Lake Warren," pp. 763-64.

LYELL, CHARLES

Travels in North America, vol. ii (1845, New York), pp. 71-74.

NEWBERRY, J. S.

"Report on Geology of Cuyahoga County," *Geol. Surv. Ohio,* vol. i (1873), pp. 171-200.

"Terraces and Beaches," *Geol. Surv. Ohio,* vol. ii (1874), pp. 50-65.

"Lake Ridges," *Geol. Surv. Ohio,* vol. iii (1878), pp. 44-45.

PIERCE, S. J.

"The Preglacial Cuyahoga Valley," *The American Geologist,* vol. xx (1897), pp. 176-81.

TAYLOR, F. B.

"Correlation of Erie-Huron Beaches and Outlets and Moraines in Southeastern Michigan," *Bull. Geol. Soc. Am.,* vol. viii (1897), pp. 31-58.

UPHAM, WARREN

"Preglacial and Postglacial Valleys of the Cuyahoga and Rocky Rivers," *Bull. Geol. Soc. Am.,* vol. vii (1896), pp. 327-48.

"Cuyahoga Preglacial Gorge in Cleveland, Ohio," *Bull. Geol. Soc. Am.,* vol. viii (1897), pp. 7-13.

WHITTLESEY, CHARLES

"Lake Erie Beaches," Second Annual Report, *Geological Survey of Ohio,* (1838), p. 55.

WRIGHT, A. A.

"Map of Beaches in Lorain and Cuyahoga Counties," *Geol. Surv. Ohio,* vol. ii (1874), p. 58.

SIX HUNDRED PLANTS OF GENERAL DISTRIBUTION IN OHIO.

JOHN H. SCHAFFNER.

A study of the plants in the Ohio State Herbarium shows 600 species to be of general distribution in the state. Most of these are also common. The number of plants generally distributed is probably much larger, at least 1,000 species, but the collections are still too imperfect to give complete data.

Since the plants thus far collected and incorporated into the herbarium are not at present kept in a fire-proof building, it was thought advisable to publish the list in order that, in case of accident or fire, the labor of so many botanists in the state might not be entirely lost.

Botrychium obliquum Muhl.
Botrychium dissectum Spreng.
Botrychium virginianum (L) Sw.
Osmunda regalis L.
Osmunda claytoniana L.
Osmunda cinnamomea L.
Onoclea sensibilis L.
Filix fragilis (L) Und.
Polystichum acrostichoides (Mx.) Schott.
Dryopteris noveboracensis (L.) Gr.
Dryopteris thelypteris (L.) Gr.
Dryopteris cristata (L) Gr.
Dryopteris marginalis (L) Gr.
Dryopteris spinulosa (Retz.) Ktz.
Phegopteris phegopteris (L.) Und.
Phegopteris hexagonoptera (Mx.) Fee.
Camptosorus rhizophyllus (L.) Link.
Asplenium angustifolium Mx.
Athyrium thelypteroides (Mx.) Desv.
Athyrium filix-foemina (L) Roth.
Adiantum pedatum L.
Pteridium aquilinum (L) Kuhn.
Equisetum arvense L.
Equisetum robustum A. Br.
Equisetum hyemale L.
Tsuga canadensis (L.) Carr.
Juniperus virginiana L.
Typha latifolia L.
Sparganium eurycarpum Englm.
Potamogeton natans L.
Potamogeton pectinatus L.
Naias flexilis (Willd.) R. & S.
Alisma plantago L.
Sagittaria latifolia Willd.
Andropogon scoparius Mx.
Andropogon furcatus Muhl.
Syntherisma sanguinalis (L.) Dulac.
Echinochloa crus-galli (L.) Beauv.
Panicum macrocarpon Le Conte.
Panicum huachucae Ashe.
Panicum virgatum L.
Panicum capillare L.

Chaetochloa glauca (L.) Scrib.
Chaetochloa viridis (L.) Scrib.
Chaetochloa italica (L.) Scrib.
Homalocenchrus oryzoides (L.) Poll.
Muhlenbergia mexicana (L.) Trin.
Muhlenbergia diffusa Willd.
Phleum pratense L.
Cinna arundinacea L.
Agrostis alba L.
Agrostis perennans (Walt.) Tuck.
Agrostis hyemalis (Walt.) B. S. P.
Danthonia spicata (L.) Beauv.
Eleusine indica (L.) Gaert.
Eragrostis purshii Schrad.
Eragrostis major Host.
Eragrostis hypnoides Lam. B. S. P.
Eatonia pennsylvanica (D. C.) Gr.
Dactylis glomerata L.
Poa annua L.
Poa pratensis L.
Poa compressa L.
Panicularia nervata (Willd.) Ktz.
Festuca elatior L.
Festuca nutans Willd.
Bromus purgans L.
Bromus tectorum L.
Bromus secalinus L.
Bromus racemosus L.
Lolium perenne L.
Agropyron repens (L.) Beauv.
Elymus virginicus L.
Elymus canadensis L.
Hystrix hystrix (L) Millsp.
Cyperus strigosus L.
Eleocharis obtusa Schultes.
Eleocharis palustris (L) R. & S.
Scirpus americanus Pers.
Scirpus lacustris L.
Scirpus atrovirens Muhl.
Scirpus lineatus Mx.
Scirpus cyperinus (L.) Kunth.
Carex asa-grayi Bail.
Carex lupulina Muhl.
Carex frankii Kunth.
Carex squarrosa L.
Carex shortiana Dew.
Carex crinita Lam.
Carex triceps Mx.
Carex gracillima Schw.
Carex granularis Muhl.
Carex oligocarpa Schk.
Carex laxiflora Lam.
Carex albursina Sheld.
Carex pennsylvanica Lam.
Carex jamesii Schw.
Carex stipata Muhl.
Carex vulpinoides Mx.
Carex rosea Schk.
Carex sparganioides Muhl.
Carex cephalophora Muhl.
Carex tribuloides Schk.
Carex cristatella Britt.
Arisaema triphyllum (L.) Torr.
Arisaema dracontium (L.) Schott.
Spathyema foetida (L.) Raf.
Acorus calamus L.
Spirodela polyrhiza (L.) Schl.
Lemna Minor L.
Tradescantia virginica L.
Juncus effusus L.
Juncus tenuis Willd.
Juncus acuminatus Mx.
Juncoides campestre (L.) Ktz.
Uvularia perfoliata L.
Uvularia grandiflora Sm.
Hemerocallis fulva L.
Allium cernuum Roth.
Allium canadense L.
Lilium canadense L.
Erythronium americanum Ker.
Erythronium albidum Nutt.
Quamasia hyacinthina (Raf.) Britt.
Asparagus officinalis L.
Vagnera racemosa (L) Mor.
Unifolium canadense (Desf.) Greene.
Salomonia biflora (Walt.) Britt.

Salomonia commutata (R. & S.) Britt.
Medeola virginiana L.
Trillium sessile L.
Trillium grandiflorum (Mx.) Salisb.
Trillium erectum L.
Smilax herbacea L.
Smilax glauca Walt.
Smilax rotundifolia L.
Smilax hispida Muhl.
Hypoxis hirsuta (L.) Cov.
Dioscorea villosa L.
Iris versicolor L.
Sisyrinchium graminoides Bick.
Cypripedium hirsutum Mill.
Galeorchis spectabilis (L.) Ryd.
Aplectrum spicatum (Walt.) B. S. P.
Saururus cernuus L.
Populus alba L.
Populus grandidentata Mx.
Populus tremuloides Mx.
Populus deltoides Marsh.
Salix nigra Marsh.
Salix fragilis L.
Salix alba L.
Salix fluviatilis Nutt.
Salix discolor Muhl.
Salix sericea Marsh.
Salix cordata Muhl.
Salix purpurea L.
Juglans nigra L.
Juglans cinerea L.
Hicoria minima (Marsh.) Britt.
Hicoria ovata (Mill.) Britt.
Carpinus caroliniana Walt.
Ostrya virginiana (Mill.) Willd.
Corylus americana Walt.
Fagus americana Sw.
Quercus rubra L.
Quercus palustris Du R.
Quercus velutina Lam.
Quercus imbricaria Mx.
Quercus alba L.
Quercus macrocarpa Mx.
Quercus platanoides (Lam) Sudw.
Ulmus americana L.
Ulmus fulva Mx.
Celtis occidentalis Mx.
Morus rubra L.
Toxylon pomiferum Raf.
Urtica gracilis Ait.
Urticastrum divaricatum (L.) Ktz.
Adicea pumila (L.) Raf.
Boehmeria cylindrica (L.) Willd.
Parietaria pennsylvanica Muhl.
Commandra umbellata (L.) Nutt.
Asarum canadense L.
Asarum reflexum Bick.
Asarum acuminatum (Ashe) Bick.
Aristolochia serpentaria L.
Rumex acetosella L.
Rumex altissimus L.
Rumex crispus L.
Rumex obtusifolius L.
Fagopyrum fagopyrum (L.) Karst.
Polygonum lapathifolium L.
Polygonum pennsylvanicum L.
Polygonum persicaria L.
Polygonum hydropiperoides Mx.
Polygonum hydropiper L.
Polygonum punctatum Ell.
Polygonum virginianum L.
Polygonum aviculare L.
Polygonum convolvulus L.
Polygonum scandens L.
Polygonum sagittatum L.
Chenopodium album L.
Chenopodium murale L.
Chenopodium hybridum L.
Chenopodium botrys L.
Chenopodium ambrosioides L.
Atriplex hastata L.
Amaranthus retroflexus L.
Amaranthus hybridus L.
Amaranthus blitoides Wats.
Phytolacca decandra L.

Mollugo verticillata L.
Claytonia virginica L.
Agrostemma githago L.
Silene stellata (L.) Ait.
Silene virginica L.
Silene antirrhina L.
Saponaria officinalis L.
Alsine media L.
Alsine longifolia (Muhl.) Britt.
Cerastium vulgatum L.
Cerastium longipedunculatum Muhl.
Arenaria serpyllifolia L.
Anychia canadensis (L.) B. S. P.
Nymphaea advena Sol.
Ceratophyllum demersum L.
Liriodendron tulipifera L.
Asimina triloba (L.) Dun.
Hydrastis canadensis L.
Caltha palustris L.
Actaea alba (L.) Mill.
Aquilegia canadensis L.
Anemone virginiana L.
Anemone canadensis L.
Anemone quinquefolia L.
Hepatica hepatica (L.) Karst.
Hepatica acuta (Pursh) Britt.
Syndesmon thalictroides (L.) Hoffmg.
Clematis virginiana L.
Ranunculus abortivus L.
Ranunculus recurvatus Poir.
Ranunculus septentrionalis Poir.
Ranunculus hispidus Mx.
Ranunculus trichophyllum (Chaix.) Bossch.
Thalictrum dioicum L.
Thalictrum purpurascens L.
Thalictrum polygonum Muhl.
Caulophyllum thalictroides (L.) Mx.
Podophyllum peltatum L.
Menispermum canadense L.
Sassafras sassafras (L.) Karst.
Benzoin benzoin (L.) Coult.
Sanguinaria canadensis L.
Chelidonium majus L.
Bicuculla cucullaria (L.) Millsp.
Bicuculla canadensis (Goldie) Millsp.
Lepidium campestre (L.) R. Br.
Lepidium virginicum L.
Sisymbrium officinale (L.) Scop.
Brassica nigra (L) Koch.
Brassica arvensis (L.) B. S. P.
Barbarea barbarea (L.) MacM.
Roripa palustris (L.) Bess.
Roripa armoracia (L.) Hitch.
Cardamine hirsuta L.
Cardamine pennsylvanica Muhl.
Cardamine purpurea (Torr.) Britt.
Cardamine bulbosa (Schr.) B. S. P.
Dentaria laciniata Muhl.
Bursa bursa-pastoris (L.) Britt.
Arabis hirsuta (L.) Scop.
Arabis laevigata (Muhl.) Poir.
Arabis canadensis L.
Sedum ternatum Mx.
Penthorum sedoides L.
Heuchera americana L.
Mitella diphylla L.
Ribes cynosbati L.
Ribes floridum L'Her.
Hamamelis virginiana L.
Platanus occidentalis L.
Opulaster opulifolius (L.) Ktz.
Spiraea salicifolia L.
Rubus occidentalis L.
Rubus nigrobaccus Bail.
Fragaria virginiana Duch.
Potentilla monspeliensis L.
Potentilla canadensis L.
Geum vernum (Raf.) T. & G.
Geum canadense Jacq.
Geum virginianum L.
Agrimonia hirsuta (Muhl.) Bick.
Agrimonia parviflora Sol.
Rosa setigera Mx.

Rosa carolina L.
Rosa humilis Marsh.
Rosa rubiginosa L.
Malus coronaria (L.) Mill.
Malus malus (L.) Britt.
Aronia nigra (Willd.) Britt.
Amelanchier canadensis (L.) Medic.
Crataegus crus-galli L.
Crataegus punctata Jacq.
Crataegus coccinea L.
Crataegus macracantha Lodd.
Crataegus tomentosa L.
Prunus americana Marsh.
Prunus serotina Ehrh.
Amygdalus persica L.
Cercis canadensis L.
Cassia marylandica L.
Gleditsia triacanthos L.
Gymnocladus dioica (L.) Koch.
Medicago lupulina L.
Melilotus alba Desv.
Melilotus officinalis (L.) Lam.
Trifolium pratense L.
Trifolium hybridum L.
Trifolium repens L.
Robinia pseudacacia L.
Meibomia nudiflora (L) Ktz.
Meibomia grandiflora (Walt.) Ktz.
Meibomia canescens (L.) Ktz.
Meibomia paniculata (L.) Ktz.
Meibomia dillenii (Darl.) Ktz.
Lespedeza frutescens (L.) Britt.
Falcata comosa (L.) Ktz.
Apios apios (L.) Macm.
Geranium maculatum L.
Geranium carolinianum L.
Oxalis violacea L.
Oxalis stricta L.
Oxalis cymosa Small.
Xanthoxylum americanum Mill.
Ptelea trifoliata L.
Ailanthus glandulosa Desf.
Acalypha virginica L.
Acalypha gracilens Gr.
Euphorbia maculata L.
Euphorbia nutans Lag.
Euphorbia corollata L.
Euphorbia commutata Eng.
Euphorbia cyparissias L.
Rhus glabra L.
Rhus radicans L.
Ilex verticillata (L.) Gr.
Euonymus obovatus Nutt.
Euonymus atropurpureus Jacq.
Celastrus scandens L.
Staphylea trifolia L.
Acer saccharinum L.
Acer rubrum L.
Acer saccharum Marsh.
Acer nigrum Mx.
Acer negundo L.
Aesculus glabra Willd.
Impatiens biflora Walt.
Impatiens aurea Muhl.
Ceanothus americanus L.
Vitis labrusca L.
Vitis aestivalis Mx.
Vitis vulpina L.
Parthenocissus quinquefolia (L.) Planch.
Tilia americana L.
Malva rotundifolia L.
Sida spinosa L.
Abutilon abutilon (L.) Rusby.
Hibiscus trionum L.
Hypericum prolificum L.
Hypericum perforatum L.
Hypericum mutilum L.
Viola palmata L.
Viola obliqua Hill.
Viola papilionacea Pursh.
Viola scabriuscula (T. & G.) Schw.
Viola canadensis L.
Viola striata Ait.
Ludwigia alternifolia L.
Epilobum coloratum Muhl.

Onagra biennis (L.) Scop.
Gaura biennis L.
Circaea lutetiana L.
Aralia racemosa L.
Panax quinquefolium L.
Sanicula marylandica L.
Sanicula gregaria Bick.
Sanicula canadensis L.
Chaerophyllum procumbens (L.) Cratz.
Washingtonia claytoni (Mx) Britt.
Washingtonia longistylis (Torr.) Britt.
Erigenia bulbosa (Mx.) Nutt.
Cicuta maculata L.
Cicuta bulbifera L.
Deringa canadensis (L.) Ktz.
Taenidia integerrima (L.) Drude.
Thaspium trifoliatum aureum (Nutt.) Britt.
Thaspium barbinode (Mx.) Nutt.
Pastinaca sativa L.
Daucus carota L.
Cornus florida L.
Cornus amomum Mill.
Cornus asperifolia Mx.
Cornus candidissima Marsh.
Cornus alternifolia L. f.
Nyssa sylvatica Marsh.
Monotropa uniflora L.
Gaylussacia resinosa (Ait.) T. & G.
Lysimachia nummularia L.
Steironema ciliatum (L.) Raf.
Steironema quadriflorum (Sims) Hitch.
Fraxinus americana L.
Fraxinus lancelota Borck.
Fraxinus pennsylvanica Marsh.
Fraxinus nigra Marsh.
Sabbatia angularis (L.) Pursh.
Gentiana andrewsii Griseb.
Vinca minor L.
Apocynum androsaemifolium L.
Apocynum cannabinum L.
Asclepias tuberosa L.
Asclepias incarnata L.
Asclepias exaltata (L.) Muhl.
Asclepias quadrifolia Jacq.
Asclepias syriaca L.
Ipomoea pandurata (L.) Meyer.
Ipomoea purpurea (L.) Roth.
Convolvulus sepium L.
Convolvulus arvensis L.
Cuscuta gronovii Willd.
Phlox paniculata L.
Phlox divaricata L.
Polemonium reptans L.
Hydrophyllum virginicum L.
Hydropbyllum appendiculatum Mx.
Phacelia purshii Buck.
Cynoglossum officinale L.
Lappula virginiana (L.) Greene.
Mertensia virginica (L.) D. C.
Lithospermum arvense L.
Verbena urticifolia L.
Verbena hastata L.
Lippia lanceolata Mx.
Teucrium canadense L.
Scutellaria lateriflora L.
Scutellaria cordifolia Muhl.
Scutellaria nervosa Pursh.
Marrubium vulgare L.
Agastache nepetoides (L.) Ktz.
Nepeta cataria L.
Glecoma hederacea L.
Prunella vulgaris L.
Physostegia virginiana (L.) Benth.
Leonurus cardiaca L.
Lamium amplexicaule L.
Stachys tenuifolia Willd.
Stachys palustris L.
Stachys asper Mx.
Monarda fistulosa L.
Blephilia ciliata (L.) Raf.
Blephilia hirsuta (Pursh) Torr.
Hedeoma pulegioides (L.) Pers.
Melissa officinalis L.
Clinopodium vulgare L.

Lycopus virginicus L.
Lycopus rubellus Moench.
Lycopus americanus Muhl.
Mentha spicata L.
Mentha piperita L.
Mentha canadensis L.
Collinsonia canadensis L.
Physalis heterophylla Nees.
Solanum nigrum L.
Solanum carolinense L.
Solanum dulcamara L.
Lycium vulgare (Ait. f.) Dun.
Datura tatula L.
Verbascum thapsus L.
Verbascum blattaria L.
Linaria linaria (L.) Karst.
Scrophularia marylandica L.
Chelone glabra L.
Pentstemon hirsutus (L.) Willd.
Pentstemon pentstemon (L.) Britt.
Collinsia verna Nutt.
Mimulus ringens L.
Mimulus alatus Sol.
Gratiola virginiana L.
Veronica officinalis L.
Veronica serpyllifolia L.
Veronica peregrina L.
Veronica arvensis L.
Leptandra virginica (L.) Nutt.
Afzelia macrophylla (Nutt.) Ktz.
Gerardia tenuifolia Vahl.
Pedicularis canadensis L.
Conopholis americana (L. f.) Wallr.
Leptamnium virginianum (L.) Raf.
Dianthera americana L.
Phryma leptostachya L.
Plantago major L.
Plantago rugelii Dec.
Plantago lanceolata L.
Plantago aristata Mx.
Houstonia coerulea L.
Houstonia longifolia Gaert.
Cephalanthus occidentalis L.
Galium aparine L.
Galium lanceolatum Torr.
Galium circaezans Mx.
Galium triflorum Mx.
Galium tinctorium L.
Galium concinnum T. & G.
Sambucus canadensis L.
Viburnum acerifolium L.
Viburnum lentago L.
Viburnum prunifolium L.
Triosteum perfoliatum L.
Symphoricarpos racemosus Mx.
Lonicera glaucescens Ryd.
Valerianella radiata (L.) Dufr.
Dipsacus sylvestris Mill.
Micrampelis lobata (Mx.) Greene.
Sicyos angulatus L.
Campanula americana L.
Specularia perfoliata (L.) A. DC.
Lobelia cardinalis L.
Lobelia syphilitica L.
Lobelia spicata Lam.
Lobelia inflata L.
Lobelia kalmii L.
Ambrosia trifida L.
Ambrosia artemisiaefolia L.
Xanthium canadense Mill.
Vernonia maxima Small.
Eupatorium maculatum L.
Eupatorium purpureum L.
Eupatorium perfoliatum L.
Eupatorium ageratoides L. f.
Solidago caesia L.
Solidago ulmifolia Muhl.
Solidago canadensis L.
Solidago nemoralis Ait.
Euthamia graminifolia (L.) Nutt.
Aster macrophyllus L.
Aster shortii Hook.
Aster cordifolius L.
Aster sagittifolius Willd.
Aster novae-angliae L.
Aster prenanthoides Muhl.
Aster laevis L.

Aster paniculatus Lam.
Aster ericoides L.
Aster lateriflorus (L.) Britt.
Erigeron pulchellus Mx.
Erigeron philadelphicus L.
Erigeron annuus (L.) Pers.
Erigeron ramosus (Walt.) B. S. P.
Leptilon canadense (L.) Britt.
Doellingeria umbellata (Mill.) Nees.
Antennaria plantaginifolia (L.) Rich.
Gnaphalium obtusifolium L.
Gnaphalium uliginosum L.
Inula helenium L.
Polymnia canadensis L.
Silphium perfoliatum L.
Heliopsis helianthoides (L.) B. S. P.
Eclipta alba (L.) Hassk.
Rudbeckia hirta L.
Helianthus tuberosus L.
Verbesina alternifolia (L.) Britt.
Coreopsis tripteris L.
Bidens cernua L.
Bidens vulgata Greene.
Bidens bipinnata L.
Bidens trichosperma (Mx.) Britt.
Achillea millefolium L.
Anthemis cotula L.
Chrysanthemum leucanthemum L.
Tanacetum vulgare L.
Erechtites hieracifolia (L.) Raf.
Mesadenia atriplicifolia (L.) Raf.
Senecio aureus L.
Arctium lappa L.
Carduus lanceolatus L.
Carduus altissimus L.
Carduus muticus (Mx.) Pers.
Carduus arvensis (L.) Robs.
Cichorium intybus L.
Adopogon virginicum (L.) Ktz.
Taraxacum taraxcum (L.) Karst.
Sonchus arvensis L.
Sonchus asper (L.) All.
Lactuca virosa L.
Lactuca canadensis L.
Lactuca spicata (Lam.) Hitch.
Hieracium scabrum Mx.
Nabalus altissimus (L.) Hook.
Nabalus albus (L.) Hook.

Proceedings

of the

Ohio State Academy of Science

VOLUME V, PART 6

Annual Report
Nineteenth Meeting

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume V, Part 6.

Annual Report

of the

Ohio State Academy of Science

Nineteenth Meeting
1909

Organized 1891 Incorporoted 1892

Publication Committee

J. C. Hambleton E. L. Rice Bruce Fink

Date of Publication, April 15, 1910

Published by the Academy
Columbus, Ohio

Officers — 1909-1910

PRESIDENT.

W. F. MERCER.

VICE-PRESIDENTS.

M. M. METCALF. BRUCE FINK.

G. D. HUBBARD.

SECRETARY.

L. B. WALTON.

TREASURER.

J. S. HINE.

LIBRARIAN.

W. C. MILLS.

EXECUTIVE COMMITTEE.

Ex-Officio.

W. F. MERCER. JAS. S. HINE. L. B. WALTON.

Elective.

L. G. WESTGATE. A. D. SELBY.

BOARD OF TRUSTEES.

W. R. Lazenby, Chairman, term expires	1912
Frank Carney, term expires	1910
E. L. Rice, term expires	1911

PUBLICATION COMMITTEE.

J. C. Hambleton, Chairman, term expires	1912
E. L. Rice, term expires	1910
Bruce Fink, term expires	1911

Past Officers

PRESIDENTS.

1892. E. W. Claypole,
1893. Edward Orton,
1894. F. M. Webster,
1895. D. S. Kellicott,
1896. A. A. Wright,
1897. W. A. Kellerman,
1898. W. G. Tight,
1899. G. F. Wright,
1900. Josua Lindahl,
1901. A. D. Selby,
1902. W. R. Lazenby,
1903. C. J. Herrick,
1904. E. L. Moseley,
1905. Herbert Osborn,
1906. E. L. Rice,
1907. Charles Dury,
1908. Frank Carney,
1909. J. H. Schaffner.

VICE-PRESIDENTS.

1892. A. A. Wright, Ellen E. Smith.
1893. D. S. Kellicott, D. L. James.
1894. G. H. Colton, Mrs. W. A. Kellerman.
1895. H. E. Chapin, Jane F. Winn.
1896. A. L. Treadwell, Charles Dury.
1897. C. E. Slocum, J. B. Wright.
1898. Josua Lindahl, J. H. Todd.
1899. Chas. E. Albright, A. D. Selby.
1900. J. A. Bownocker, Lynds Jones.
1901. H. Herzer, Mrs. W. A. Kellerman.
1902. C. J. Herrick, C. S. Prosser.
1903. J. A. Bownocker, Miss L. C. Riddle.
1904. Lynds Jones, L. H. McFadden.
1905. C. W. Dabney, F. M. Comstock.
1906. Charles Dury, Lynds Jones.
1907. W. F. Mercer, Frank Carney.
1908. J. H. Schaffner, F. C. Waite.
1909. L. G. Westgate, S. R. Williams.

TREASURERS.

1892-95. A. D. Selby,
1896-98. D. S. Kellicott,
1899-04. Herbert Osborn,
1905-10. Jas. S. Hine.

LIBRARIAN.

1904-10. W. C. Mills.

SECRETARIES.

1892.	W. R. Lazenby,	1895-03.	E. L. Moseley,
1893-94.	W. G. Tight,	1904.	F. L. Landacre,

1905-10. L. B. Walton.

TRUSTEES.

1900-04.	F. M. Webster,	1901-09.	W. R. Lazenby,
1900-02.	H. C. Beardslee,	1905-08.	G. B. Halsted,
1904-06.	C. J. Herrick,	1907-08.	Chas. Dury,
1900-05.	J. H. Schaffner,	1908-10.	Frank Carney,

1908-11. E. L. Rice.

PUBLICATION COMMITTEE.

1892-01.	F. M. Webster,	1901-03.	L. H. McFadden,
1892-97.	W. A. Kellerman,	1902-04.	Gerard Fowke,
1892-96.	E. W. Claypole,	1904-05.	Jas. S. Hine,
1897-99.	E. L. Moseley,	1905.	E. L. Rice,
1898-00.	S. Belle Craver,	1906.	J. C. Hambleton,
1900-08.	J. H. Schaffner,	1908.	Bruce Fink.

Membership

MAY 1, 1909.

Life Member

McMillin, Emerson E..........320 Riverside Drive, New York, N. Y.

Patron

Slocum, C. E..Defiance

Active Members

Aiken, W. H......................................Station K, Cincinnati
Albright, Charles E...Columbus
Armstrong, C. A., *Geology*....................1110 Chance Ave., Canton
Bachman, Freda M., *Biology*.............310 Bruen St., Madison, Wis.
Badertscher, J. A., *Histology, Embryology, Physiology*..........Athens
Bales, B. R., *Ornithology, Entomology*......149 W. Main St., Circleville
Ball, E. D., *Entomology*................................Logan, Utah
Banta, A. M., *Biology*.....................Cold Spring Harbor, N. Y.
Barrows, William M., *Experimental Zoology*,......O. S. U., Columbus
Bell, Edith C., *Biology*.....................................Mt. Vernon
Benedict, H. M........................Univ. of Cincinnati, Cincinnati
Berger, E. W., *Zoology*............................Gainesville, Florida
Blackman, M. W.........Western Reserve Medical College, Cleveland
Blair, Kate R..............................1501 Neil Ave., Columbus
Bolin, W. C., *Engineering*........................R. F. D. No. 1, Newark
Bonser, T. A., *Botany, Geology*......2217 Monroe St., Spokane, Wash.
Bownocker, John A., *Geology*.........................O. S. U., Columbus
Box, Cora May, *Zoology*................Univ. of Cincinnati, Cincinnati
Braam, Maximilian, *Biology*..........Hughes High School, Cincinnati
Branson, E. B..Oberlin
Braun, Annete F., *Zoology*.............Univ. of Cincinnati, Cincinnati
Brockett, Ruth E., *Botany*...............................Rio Grande
Brookover, Chas. ....Buchtel College, Akron
Brugger, Harvey, *Botany*....................218 N. Wood St., Fremont
Bubna, Matthias, *Entomology*..........2629 Woodhill Road, Cleveland
Budington, R. A., *Zoology, Physiology*.........................Oberlin
Burgess, A. F., *Entomology*........U. S. Dept. Ag., Washington, D. C.
Carney, Frank, *Geology*.......................................Granville
Claassen, Edo., *Botany*..............18 Fernwood Ave., East Cleveland
Clark, Howard, *Geology*.......................................Granville
Clevenger, J. F., *Botany*...................838 E. 57th St., Chicago, Ill.

COGHILL, GEO. E., *Zoology, Neurology*........................Granville
COLE, A. D., *Physics*.......................................Columbus
COLTON, GEORGE H..Hiram
COMSTOCK, FRANK M., *Vert. Zoology*............Case School, Cleveland
COTTON, E. C., *Entomology*...........Experiment Sta., Knoxville, Tenn.
COPELAND, W. F...Athens
CRAMER, WILLIAM G., *Zoology*............273 Southern Ave., Cincinnati
DABNEY, CHAS. W......................Univ. of Cincinnati, Cincinnati
DACHNOWSKI, ALFRED, *Botany*......................O. S. U., Columbus
DAVIES, CLARA A., *Botany, Physics*...........................Granville
DAVIS, V. H., *Horticulture*........................O. S. U., Columbus
DAVIS, B. M., *Zoology*...Oxford
DETMERS, FREDA, *Botany*...........................O. S. U., Columbus
*DICKEY, MALCOLM G., *Botany*......................O. S. U., Columbus
DOREN, JANE MACARTNEY, *Botany, Zoology*.....................
..............................1659 Franklin Park South, Columbus
DURRANT, E. P., *Biology, Geology*..........................Westerville
DURY, CHAS. ....537 Ridgway Ave., Cincinnati
DUTTON, C. F., JR........................4816 Franklin Ave., Cleveland
EDWARDS, E. H., *Zoology, Physiology*..........................
..............................7317 Clinton Ave., N. W., Cleveland
FEIEL, ADOLPH ....520 E. Main St., Columbus
FENNEMAN, N. M., *Geology, Geography*...Univ. of Cincinnati, Cincinnati
FETZER, BERTHA A., *Zoology*..................................Granville
FINK, BRUCE, *Botany, Zoology*..................................Oxford
FISCHER, WALTER, *Botany*..................................Para, Brazil
FITZGERALD, A. D., *Histology, Pathology*....................Reynoldsburg
FLETCHER, M. H.................................11 E. 7th St., Cincinnati
FLYNN, MAUD, *Zoology*.......................338 W. 6th Ave., Columbus
FOOTE, E. H., *Biology*.......................................Granville
FOX, CHAS. P., *Botany, Chemistry*................395 Doyle St., Akron
FOWKE, GERARD, *Glacial Geology, Archaeology*...............Chillicothe
FRANK, J. N., *Botany, Entomology*........................Colleton, S. C.
FULLMER, E. L., *Botany*...Berea
FULTON, B. B., *Entomology, Botany*...........................Newark
GARY, L. B., *Geology*........................263 Hoyt St., Buffalo, N. Y.
GIBBS, DAVID ....Milan
GROVER, F. O., *Botany*.......................................Oberlin
GRIGGS, R. F., *Botany*...........................O. S. U., Columbus
GUYER, M. F..........................Univ. of Cincinnati, Cincinnati
HAMBLETON, J. C., *Botany, Zoology*..........212 E. 11th Ave., Columbus
HANSEN, MRS. HERMINA J., *Biology*....Hughes High School, Cincinnati

---

*Subject to ratification of the Society at the annual meeting, 1910.

Hathaway, Edward S., *Zoology, Botany*..Univ. of Cincinnati, Cincinnati
Hawk, J. F., *Biology*..............................Box 302, Lancaster
Hawkins, L. A., *Botany*.......Bureau of Plant Ind., Washington, D. C.
Hayes, Seth....................................135 Center St., Dayton
Henninger, W. F., *Ornithology, Entomology*...............New Bremen
Herms, W. B........................Univ. of California, Berkeley, Cal.
Herzer, H., *Paleontology*.................................Marietta
Hillig, Fred J..............................St. John's College, Toledo
Hine, J. S., *Entomology, Ornithology*................O. S. U., Columbus
Hobbs, P. L., *Chemistry*.......Western Reserve Med. College, Cleveland
Hollister, Emily S...............................O. S. U., Columbus
Holt, W. P., *Botany*..........................2113 Putnam St., Toledo
Hood, G. W., *Entomology, Horticulture*.......57 W. 8th Ave., Columbus
Hóuser, J. S., *Entomology*.................Santiago de las Vegas, Cuba
Hubbard, G. D., *Geology, Physiography*..............O. S. U., Columbus
Hyde, J. E., *Geology*......................................Lancaster
Jackson, C. F., *Zoology*...............................Durham, N. H.
James, C. B...............................Adelbert College, Cleveland
Jennings, O. E., *Botany*........Carnegie Museum Annex, Pittsburg, Pa.
*Johnson, Dora E., *Botany, Physiography*......................Medina
Jones, Lynds, *Ornithology*...................College Museum, Oberlin
Judson, C. A., *Botany*....................235 Columbus Ave., Sandusky
King, J. Lional, *Botany, Entomology*.......................Cleveland
Krecker, Frederick H., *Biology*.............................Marietta
Lamb, G. F., *Biology, Geology*...............Mt. Union College, Alliance
Landacre, F. L., *Zoology*..........................O. S. U., Columbus
Lazenby, Wm. R., *Horticulture, Botany*.............O. S. U., Columbus
Lee, Mary E., *Geology*....................................Westerville
Lett, Gertrude, *Biology*....................................Granville
Library, Ohio State University...............................Columbus
Lindahl, Josua, *Zoology*...................5700 Peoria St. Chicago, Ill.
Lloyd, John Uri.......................Court and Plum Sts., Cincinnati
Luginbill, Philip, *Entomology*..............247 E. 11th Ave., Columbus
Mackenzie, Mary D., *Biology*...................................Oxford
Mally, C. W., *Entomology*....................Grahamstown, S. Africa
March, Cora, *Biology*...Wyoming
Matheny, W. A...................Clark University, Worcester, Mass.
Mather, Kirtley F., *Geology*.................................Granville
Mathews, Mary E...Painesville
McCall, A. G., *Agronomy*............................O. S. U., Columbus
McCampbell, Eugene F., *Bacteriology*..............O. S. U., Columbus
McCleery, Edna, *Botany*......................................Lancaster

*Subject to ratification of the Society at the annual meeting, 1910.

McCoy, C. T., *Botany*....................................Lancaster
McCray, Arthur H., *Zoology and Entomology*..................Duval
McDaniel, J. E., *Biology*............................Olathe, Colo.
McFadden, L. H., *Chemistry*..................40 Warden St., Dayton
McKean, T. L., *Botany*..Berea
Mead, Chas. S., *Zoology, Botany*......2020 Orrington Ave., Chicago, Ill.
Mercer, W. F., *Biology*.......................Ohio University, Athens
Metcalf, C. L., *Botany, Zoology*............86 E. 11th Ave., Columbus
Metcalf, M. M., *Zoology*....................................Oberlin
Metcalf, Zeno P...Raleigh, N. C.
Mills, W. C., *Archaeology, Biology*................O. S. U., Columbus
Moody, A. E...Flushing
Morgulis, S., *Zoology*................Harvard Univ., Cambridge, Mass.
Morse, W. C., *Biology, Geology*....................O. S. U., Columbus
Moseley, E. L., *Zoology, Botany, Physiography*...............Sandusky
Nelson, James A., *Zoology, Embryology*........................
..............U. S. Dept. Agricul. Div. Entom., Washington, D. C.
Nichols, Susan P., *Botany*......................Oberlin College, Oberlin
Oberholser, H. C............1445 Girard St., N. W., Washington, D. C.
Odenbach, F. L., *Meteorology*............St. Ignatius College, Cleveland
Orcutt, Alfred S..Granville
Osborn, Herbert, *Entomology, Zoology*..............O. S. U., Columbus
Osburn, Raymond C., *Zoology, Ichthyology*.......................
.................................Columbia Univ., New York, N. Y.
Oxley, Chas. E., *Geology, Physics*...........................Coshocton
Pallister, H. D....................3754 Independence Road, Cleveland
Parkhurst, C. P., *Science*.....................9 W. Long St., Columbus
Peaslee, L. D., *Zoology*...............................U. of C., Cincinnati
Pickel, Geo. J., *Chemistry*..............St. Ignatius College, Cleveland
Piwonka, Thomas.................226 Superior Ave., N. W., Cleveland
Prosser, C. S., *Geology*..............................O. S. U., Columbus
Rice, Edward L., *Zoology*....................................Delaware
Roudebush, Lowell..................R. F. D. No. 3, New Richmond
Royer, John S., *Biology*.......................................Bradford
Sanders, J. G., *Entomology, Botany*.......................Madison, Wis.
Sanders, A. E............................Steele High School, Dayton
Sanger, U. G., *Botany*..Newark
Sauer, Lewis W., *Botany*...Central Ave. and Bay Miller St., Cincinnati
Schaffner, J. H., *Botany*.............................O. S. U., Columbus
Scheffel, Earl R., *Geology*............469 College Ave., Appleton, Wis.
Scott, L. L., *Entomology*..Kent
Seaton, Miss F..........................1943 E. 86th St., Cleveland
Selby, A. D., *Botany*......................Experiment Station, Wooster
Sessions, Elizabeth, *Botany and Zoology*....59 Wilson Ave., Columbus

Shade, Ernest F., *Physiography, Botany, Physics*............... Medina
Shatzer, C. G........................... Wittenberg College, Springfield
Shaw, N. E., *Entomology*........................ O. S. U., Columbus
Sim, Robert J.................................... O. S. U., Columbus
Smith, A. L., *Geology*............................ O. S. U., Columbus
Smead, Anna, *Biology*.......................... 624 Nestle St., Toledo
Smith, Ethel M.................................. Stevens Point, Wis.
Smith, G. D., *Botany, Zoology*........................... Richmond, Ky.
Smith, J. Warren, *Meteorology*........ Weather Bureau, St. Louis, Mo.
Snyder, F. D., *Zoology, Ethnology*.......................... Ashtabula
Stair, L. D................................. 611 Y. M. C. A., Toledo
Stauffer, Clinton R., *Geology*................ W. R. Univ., Cleveland
Sterki, Victor, *Conchology, Botany*.................. New Philadelphia
Stickney, M. E., *Botany*.................................... Granville
Stockberger, W. W., *Botany*...... Dept. Agriculture, Washington, D. C.
Stover, W. Garfield, *Botany*............. Miami University, Oxford
Stout, W. E., *Chemistry, Geology*........... 1464 S. High St., Columbus
Surface, F. M., *Zoology, Botany*........................ Orono, Maine
Sweezey, Otto H....................... 12th Ave., Honolulu, Hawaii
Todd, Joseph H., *Geology, Archaeology*....... Christmas Knoll, Wooster
Thomas, Lewis, *Geology*.................................... Granville
True, H. L.. McConnelsville
Tyler, F. J., *Botany*................................ Perry, Lake County
Waite, F. C..................... Western Reserve University, Cleveland
Walton, L. B., *Biology*..................................... Gambier
Webb, R. J., *Botany*.................................. Garrettsville
Webster, F. M., *Entomology*.... U. S. Dept. Agricul., Washington, D. C.
Werthner, William, *Botany*................ Steele High School, Dayton
Westgate, Lewis G., *Geology*............................... Delaware
Wetzstein, A., *Botany*......... 748 Pleasant St., Hot Springs, Arkansas
Wieman, Harry L., *Biology*............ Univ. of Cincinnati, Cincinnati
Williams, Stephen R., *Biology*.............. Miami University, Oxford
Williamson, E. B., *Ichthyology, Ornithology*............. Bluffton, Ind.
Wilson, Stella S., *Geography, Geology*........ 97 N. 20th St., Columbus
Wineland, L. A., *Chemistry*............................ Westerville
Wittenmyer, J. G., *Zoology*................................ Peebles
Wolfe, E. E., *Botany*....................... Marietta College, Marietta
Wright, G. Frederick, *Geology*.............................. Oberlin
York, Harlan H., *Botany*............... Univ. of Texas, Austin, Texas
Young, R. A., *Botany*...
.... Div. Seed and Plant Introduction, Washington, D. C.

Report of the Nineteenth Annual Meeting

of the

Ohio State Academy of Science

ANNUAL MEETING

The nineteenth annual meeting of the Academy was held at Ohio Wesleyan University, Delaware, O., on November 25, 26 and 27, the President, Prof. J. H. Schaffner, presiding. On Thursday evening an informal reception was held in Merrick Hall, where refreshments were served and acquaintances renewed. Through the generosity of the university authorities acting in co-operation with various fraternities, accommodations were provided for all visiting members.

The meeting was called to order on Friday morning at 9:00 in Merrick Hall by the President of the Academy after a preliminary meeting of various committees. An address was made by President Welch extending the cordial greetings of the University to the society and calling attention to the influence of science in promoting accuracy, in broadening scholarship, and in the adjustment of theory to fact rather than fact to theory.

In the regular business meeting which followed a committee on membership consisting of Professors Moseley, Rice, and Miss Davies, and a committee on resolutions consisting of Professors Osborn, Guyer, and Metcalf, were appointed by the President. The report of the Secretary was presented and accepted. This was followed by the report of the Treasurer, Prof. J. S. Hine which after being referred to an auditing committee consisting of Professors Stickney and Guyer was accepted. The report of the Treasurer is as follows:

REPORT OF THE TREASURER FOR THE YEAR 1909.

The revised constitution of the Academy adopted at the annual meeting for the year 1908 at Granville provides that a single payment of twenty-five dollars shall be accepted from any member as commutation of dues for life, also that the payment of one hundred dollars at one time shall constitute eligibility to election as a patron of the society. Money paid in according to this plan is intended eventually to constitute a research fund of which the income alone shall be used for the encouragement of research and for the publication of papers bearing upon the development of science in the state.

Dr. Charles E. Slocum, of Defiance, was the first to respond with a hundred dollars and at the present time is the only patron of the Academy. Dr. Slocum's example is one worthy of emulation and a long list of patrons would look well at the head of our membership role.

For the year since our last annual meeting the receipts, including balance for last year, have amounted to $342.49, and the expenditures to $286.12, leaving a cash balance of $56.37.

RECEIPTS.

Balance from last year	$14 99
Dr. C. E. Slocum — payment on becoming a patron of the Academy	100 00
Membership dues	227 50
Total	$342 49

DISBURSEMENTS.

170 subscriptions to the Ohio Naturalist	$127 50
Annual report for 1907	25 50
Annual report for 1908	82 50
Miscellaneous expenses	50 62
Balance December 1, 1909	56 37
Total	$342 49

Respectfully submitted,

James S. Hine.

The report of the Librarian, Prof. W. C. Mills, was then presented as follows:

REPORT OF THE LIBRARIAN FOR THE YEAR 1909.

COLUMBUS, OHIO, November 26, 1909.

As Librarian of the Ohio Academy of Science I take pleasure in presenting my report upon the receipts from the sale of publications of the Academy and the expense of sending out the publications:

Cash on hand November 27, 1908	$3 54	
Sale of publications	33 79	
		$37 33

Expenditures from November 27, 1908 to November 26, 1909:

Letter postage	$1 22	
Sending out Special Paper No. 14, 220 @ .04	8 80	
Sending out Special Paper No. 15, 210 @ .06	12 60	
Sending out Seventeenth Annual Report, 215 @ .04	8 60	
Sending out publications during year	2 41	
Envelopes for sending out publications	2 35	
Stationery	1 00	
Paste	15	
		$35 91
Balance		$1 42

It is gratifying to note the increased sale in our publications. Last year our entire sales amounted to $16.35, while this year the sales were more than doubled. This is perhaps due to the sale of special paper No. 15 by Prof. Schaffner.

The increased number of answers to inquiries can be seen in the amount expended for letter postage, which is $1.22. Many more contained stamp for return postage. During the year 212 letters have been written, averaging more than 4 letters per week.

Our exchanges have also been somewhat increased, and during the year we have been sending our publications to the following scientific and educational institutions: Academy of Natural Sciences of Philadelphia, Brooklyn Institute of Arts and Sciences, Buenos Aires National Museum, Buffalo Society of Natural Sciences, Connecticut Academy of Arts and Sciences, New Haven, Cincinnati Society of Natural History, Denison University Scientific Laboratory, Davenport Academy of Sciences, Illinois State Laboratory, Kansas Academy of Science, Topeka. New York Botanical Garden, University of California, Wisconsin Academy of Sciences, Arts and Letters, University of Missouri, Columbia, British Museum of Natural History, Missouri Botanical Garden, and Chicago Academy of Science.

The reports and bulletins received from these exchanges are placed in a section in the Library of the Ohio State Archaeological and Historical Society. These volumes can be consulted by the members of the Academy at any time.

Respectfully submitted,
WM. C. MILLS,
Librarian.

The report was followed by a discussion relative to the prices which should be charged for the publications of the Society. A resolution was finally adopted that the Publication Committee be instructed to increase the prices for the papers published by the Society.

Under reports of Standing Committees, the Program Committee advised the papers presented "in absentia" be transferred to the end of the program.

Professor Lazenby, chairman of the Board of Trustees presented the following report which was approved and accepted. The continued interest of Mr. Emerson McMillin in the welfare of the society was made known through his gift of $250 to the research fund. The report of the trustees is as follows:

REPORT OF THE BOARD OF TRUSTEES.

The financial statement of the Emerson McMillin research fund for the year 1908-1909, is herewith presented:

RECEIPTS.

1908.			
	Balance on hand November 1, 1908..........	$469 67	
	Check from Emerson McMillin, November 20, 1908	250 00	
	Total		$719 67

EXPENDITURES.

1908.		
Dec. 26.	Bucher Engraving Co., illustrations for S. Morgulis	$6 50

1909.			
Feb.	8.	Dr. A. Dachnowski, expense in research in physiological botany	10 00
Mar.	8.	Prof. G. E. Coghill, expense in research in zoology	27 94
Apr.	12.	Prof. L. B. Walton, expense in research in zoology	17 50
	20.	Dr. A. Dachnowski, expense in research in physiological botany	26 10
May	26.	Prof. G. E. Coghill, expense in research in zoology	7 84
	26.	F. J, Heer Printing Co., 500 copies Discomycetes in the vicinity of Oxford, Ohio, by Freda M. Bachman..................	44 00
	26.	F. J. Heer Printing Co., 700 copies, Trees of Ohio, by J. H. Schaffner...............	124 50
June	8.	Prof. L. B. Walton, expense in research in zoology	5 63
Aug.	16.	Miss Freda Detmers, expense in research in systematic botany	20 75
Oct.	19.	Miss Freda Detmers, expense in research in systematic botany	9 25
	20.	Prof. G. E. Coghill, expense in research in zoology	7 75
	20.	Mr. R. J. Sim, expense in research in ornithology	40 47

Total $348 23

Balance on hand Nov. 1, 1909.................. $371 44

Of this balance there has been appropriated a grant of $50.00, which is not yet expended, leaving an unappropriated balance for the year 1908-1909 of $321.44.

WILLIAM R. LAZENBY,
Chairman.

The Publication Committee consisting of Professors J. C. Hambleton, E. L. Rice, and Bruce Fink, presented the following report which was accepted:

REPORT OF THE PUBLICATION COMMITTEE.

The following publications have been issued the past year: Special Paper No. 14, Discomycetes in the Vicinity of Oxford, Ohio, by Freda

M. Bachman. Special Paper No. 15, The Trees of Ohio, by John H. Schaffner, and the Seventeenth Annual Report.

Respectfully submitted,

J. C. HAMBLETON, *Chairman.*

Under the reports of special committees, the Natural History Survey committee was continued. The Committee on joint meetings with the Indiana Academy reported on the desirability of such a meeting. This was referred to the Executive Committee for consideration in 1910. The Committee on the Conservation of Natural Resources consisting of Professor Herbert Osborn, chairman, Professor Lazenby, Professor Bownocker, and Professor Walton was continued, while the chairman of the committee was given power to appoint a member in place of J. Warren Smith who, much to the regret of the members of the society, has been transferred in connection with the Weather Bureau Service.

After the election of a Nominating Committee consisting of Professors Rice, Osborn and Stickney, the business meeting was adjourned until Saturday morning at 8:00 a. m., while the society proceeded with the reading of papers, adjourning at 12:00 m. for luncheon.

The afternoon session opened with the address of the President, Professor J. H. Schaffner, which will be found on another page. This was followed by the reading of papers, the society adjourning at 5:00 p. m.

At 5:30 dinner was served in Monnett Hall by the university, following which the aims and history of the Academy were presented in a series of speeches from some of the older members of the society. The social evening which followed was one of the particularly enjoyable features of the meeting.

Saturday at 8:00 p. m. occurred the adjourned business meeting. The report of the nominating committee was received and the following officers were elected for the ensuing year:

OFFICERS OF THE OHIO ACADEMY OF SCIENCE FOR 1909-10.

President — Professor W. F. Mercer, Athens, Ohio.
Vice-Presidents — Botany, Professor Bruce Fink, Oxford, Ohio; Geology, Professor G. D. Hubbard, Columbus, Ohio; Zoology, Professor M. M. Metcalf, Oberlin, Ohio.
Secretary — Professor L. B. Walton, Gambier, Ohio.
Treasurer — Professor J. S. Hine, Columbus, Ohio.
Librarian — Professor W. C. Mills, 3 years, Columbus, Ohio.
Trustee — Professor W. R. Lazenby, 3 years, Columbus, Ohio.
Publication Committee — Professor J. C. Hambleton, 3 years, Columbus, Ohio.
Executive Committee — Professor L. G. Westgate, Delaware, Ohio; Dr. A. D. Selby, Wooster, Ohio.

HERBERT OSBORN,
EDWARD L. RICE,
MALCOLM E. STICKNEY,
Committee.

The following members were upon the report of the membership committee appointed at the opening session:

NEW MEMBERS ELECTED AT THE DELAWARE MEETING, 1909.

Badertscher, J. A., Histology, Embryology, Physiology............Athens
Barrows, William Martin, Experimental Zoology.....O. S. U., Columbus
Braun, Annete F., Zoology................Univ. of Cincinnati, Cincinnati
Fulton, B. B., Entomology, Botany............................Newark
Hathaway, Edward S., Zoology, Botany...Univ. of Cincinnati, Cincinnati
Hollister, Emily S., Zoology........................O. S. U., Columbus
Hood, G. W, Entomology, Horticulture.......57 W. 8th Ave., Columbus
King, J. Lional, Botany, Entomology.........................Cleveland
Krecker, Frederick H., Biology..............................Marietta
Lamb, G. F., Biology, Geology..............Mt. Union College, Alliance
Luginbill, Philip, Entomology...............249 E. 11th Ave., Columbus
McCleery, Edna, Botany....................................Lancaster
Metcalf, C. L., Botany, Zoology.............86 E. 11th Ave., Columbus
Nichols, Susan P., Botany......................Oberlin College, Oberlin
Shade, Ernest F., Physiography, Botany, Physics................Medina
Stover, Wilmer Garfield, Botany...............Miami University, Oxford

The names of members proposed by the executive committee and provisionally placed on the list of membership were also ratified.

The committee on resolutions reported as follows:

Be it resolved, That we express to Mr. Emerson McMillin our great appreciation of his continued interest. His substantial contributions have done and are doing much in promoting the scientific accomplishments of the Academy and we extend to him our sincere thanks.

Be it further resolved, That we extend our hearty thanks to the President, Trustees and Faculty of Ohio Wesleyan University, to the fraternities of the university, to the residents of Monnett Hall and to the local committee for our delightful entertainment and their careful arrangements which have insured the success of our meeting.

Herbert Osborn,
Michael F. Guyer,
Maynard M. Metcalf,
Committee.

In connection with the new business the following resolution was adopted. It is assumed that the resolution only applies to papers exceeding three minutes in length.

1. That the presiding officers be required to close the reading of papers at the expiration of the time set on the program.
2. That a signal be given two minutes previous to the time when the paper must be closed.
3. That this procedure be printed as a note on the program of papers for the meeting.

Telegrams extending cordial greetings were exchanged with the Indiana Academy of Science in session at Indianapolis.

At the close of the business session the society proceeded with the reading of papers.

At 11:45 a. m. the Academy was formally declared adjourned.

The complete program of the meeting was as follows:

1. A Suspected Belgian Hare — Cat Hybrid (Demonstration). 5 min. — E. L. Rice
2. The Film Test for Crude Rubber. 5 min. — Chas. P. Fox
3. Development of Skeletal System in young leaves. 10 min. — H. H. Benedict
4. The Relation of Bodily Strength to Correlation of height and arm length in some College Students. 10 min. — W. M. Barrows

5. On Mitosis in *Synchtrium* with some observations on the Individuality of the chromosomes. 12 min. R. F. Griggs
6. The Life History of *Corizus lateralis* Say. 10 min. J. C. Hambleton
7. The Orchids of Ohio. 5 min. Kate R. Blair
8. The Inheritance of the Abnormality of the Human Hand. 10 min. (Lantern slides.) S. R. Williams
9. A Theory as to the Factor causing Death among Organisms. 5 min. L. B. Walton
10. The Color Pattern of Guinea-Chicken Hybrids. 8 min. M. F. Guyer
11. Relation of starch grains to Pyrenoids in green algae. 8 min. M. L. Stickney
12. Organization of protoplasm in Amœba. 5 min. R. A. Budington
13. Milk-Sickness in Sandusky County during 1909. 10 min. E. L. Moseley
14. Fossil sponges. 7 min. Herman Herzer
15. A Method for Rendering Plant Tissues Transparent. 3 min. H. M. Benedict.
16. Some Minute Parasites of Amœba. 5 min. M. M. Metcalf
17. New and Rare Ohio Plants. 5 min. J. H. Schaffner
18. The Relation of Soil Temperature and Evaporation to Plant Growth in Bogs. 10 min. Alfred Dachnowski
19. The Rate of Evaporation in a Bog Habitat. 12 min. Malcolm Dickey
20. Interesting Fungi from the Miami Valley. 15 min. W. G. Stover
21. Fossil Sponges. 10 min. Herman Herzer
22. Raised Beaches in the Bellevue Quadrangle. 10 min. (Lantern slides.) Frank Carney
23. Notes on the Work of Small Streams crossing the Ohio Shales. 8 min. E. B. Branson
24. The Mount Tabor Cave. 10 min. G. D. Hubbard
25. The Glaciation of the Newark-Zanesville Divide Area. 15 min. K. F. Mather
26. A Detailed Study of a portion of Ohio Stratigraphy. 8 min. G. F. Lamb
27. Buckeye Poisoning. 8 min. E. L. Moseley
28. Additions to the Flora of Cedar Point, O. 3 min. Clara Davies
29. Dichotomous Panicums of Ohio. 5 min. Freda Detmers
30. Notes on the Supposed Hybrid of the Black and Shingle Oaks. 8 min. E. H. Foote
31. Discomycetes of the Cuyahoga Valley. 10 min. (Lantern slides.) G. D. Smith

32. Nutrition of Egg in *Leptinotarsa synaticollis.* 15 min. H. L. Wieman
33. Notes on a New Species of Gregarine. 10 min. R. A. Budington
34. A case of Unusual Abundance of one of the Moth-flies. 5 min. J. S. Hine
35. Phylogeny of the Lithocolletid Group. 10 min. Annete F. Braun
36. The Eggs and Young of *Lepisma domestica* Pack. 5 min. S. R. Williams
37. The Place of Origin of the Lateral Line Organs in Ameiurus. 5 min. F. L. Landacre
38. Notes on the Life History and Behavior of the Opossum (*Didelphys virginiana*). 10 min. (Lantern slides.) G. E. Coghill
39. Isolation and Specialization in the Mallophaga. 15 min. E. P. Durrant
40. The Plant Productions of Burbank. 20 min. (Lantern slides.) G. D. Smith
41. Notes on Lichens — Ecologic Studies. 15 min. (Lantern slides.) Bruce Fink
42. The Lichens of the Kentucky Mountains. 10 min. (Lantern slides.) G. D. Smith
43. The Development of the Metacarpal Bones of Domesticated Animals. 20 min. J. A. Badertscher
44. The Chromosomes of *Leptinotarsa synaticollis.* 15 min. H. L. Weiman
45. The Carboniferous Deposits of Jackson and Vinton Counties. 15 min. W. F. Mercer
46. Some New Fishes from the Ohio Shales. 10 min. E. B. Branson
47. Fossil Fish Teeth. 10 min. Herman Herzer
48. Notes on the Naiades of Grand River, O., and of Cedar Point, O. 5 min. L. B. Gary
49. The Land Planarians of North America. 5 min. L. B. Walton
50. Notes upon Plant Crystals. 5 min. W. R. Lazenby
51. Early History of Germ Cells in *Leptinotarsa synaticollis.* 15 min. H. L. Wieman

L. B. Walton,
Secretary.

Gambier, Ohio, February 21, 1910.

PRESIDENT'S ADDRESS.

THE NATURE AND DEVELOPMENT OF SEX IN PLANTS.*

JOHN H. SCHAFFNER.

ORIGIN OF SEXUALITY.

Sexuality is all but universal in the organic kingdom. It is only in the lowest forms that sexual qualities are apparently lacking. Some of the intermediate and higher plants also show a lack of the sexual process but their morphology and relationships clearly point to a sexual ancestry. They are degenerate or specialized forms which have lost their sexual organs to a greater or less degree.

Now the question arises as to whether the simplest nonsexual plants, like the blue-green algae and bacteria, are not also such degenerate forms derived from sexual progenitors? In other words, were the primitive, original plants nonsexual in character like some of the present protophyta or did they possess sexual properties like the vast majority of the lower and higher plants of today? Is sexuality a property of the protoplasm normally coming to expression at some stage of the life cycle or is it an acquired character developed through mutation or the struggle for existence? There is of course no known scientific answer to these questions at present. The answer can be only a speculation or an hypothesis but apparently the general evidence points to a nonsexual starting point for the organic kingdom.

Since the nonsexual condition is evidently less complex than the sexual, it is probably proper to accept the hypothesis with-

---

*Contribution from the Botanical Laboratory of the Ohio State University, 54.

out definite proof that the primitive plants were without sex. With such an assumption the development of sex in all of its phases becomes an evolutionary process, — a process becoming more and more complicated as we go up the scale of organic beings. If the archaic organisms were nonsexual, it is probable that most of our lowest nonsexual forms have come through all the geological ages in this primitive condition. They were probably specialized before their cells had developed a conjugation process. It is evident that if plants came from nonsexual progenitors there should be no insurmountable difficulty in the way of their return to the same condition after developing sexuality. Vegetative propagation and parthenogenesis are present all along the scale of organic ascent and are not impossible in any group of plants.

In the lower plants zoospore production is very general outside of the fission plants, and it is probable that sexuality had its origin in practically all groups at the naked, motile stage of the life cycle. Whenever conjugation takes place between walled cells we may reasonably look upon the process as derived from a naked cell conjugation. Such forms as Spirogyra and Mucor become, from this point of view, extremely specialized types rather than primitive ones.

Now whatever may have been the ultimate cause of the evolution of a conjugation process, it is commonly believed that the immediate cause was a need of nutrition or rejuvenescence. If an interchange of food could be brought about when a weaker zoospore met a stronger one, the habit might become established, and if two protoplasmic masses could learn to fuse more or less completely on the approach of adverse conditions the fused individuals might have the advantage in passing through the unfavorable period. For after conjugation the number of individuals would be but half of the previous number and the protoplasm would be more dense. In the lower forms conjugation frequently takes place before the appearance of adverse conditions and the zygote passes into a resting stage in which it can endure both dryness and cold or a lack of food. There is also a considerable reduction of the surface in proportion to the volume. In the primitive forms conjugation was probably developed mostly for protection. It preceded an encysted resting condition. In the lower algae Sphaerella, Spirogyra, Ulothrix, and Vaucheria are examples. In the higher plants the conjugation was finally followed shortly by germination because the gametes are protected in the tissue of the parent. Thus in the higher plants and animals conjugation often appears to have a very different purpose from its primitive significance, since it appears here to be especially a stimulus to further growth.

In the algae it is evident that the purpose of sexuality was not to obtain the advantage of a double number of chromosomes, for in most of the lower forms the number is reduced as soon as the zygote germinates. If, however, there is a mixture of the maternal and paternal chromosomes such temporary conjugations of nuclei may be important in inducing greater variation. But by continued conjugations all the more important combinations would finally be accomplished and sexuality would thus have a tendency to produce uniformity. Of course, it is probable that the original conjugations were merely cytoplasmic, the two nuclei learning to fuse but gradually.

Our hypothesis, then, is that organisms learned to conjugate through the taking of food, the weaker from the stronger. When this habit was established it led to other habits, the plants which were able to conjugate obtained the advantage at the approach of adverse conditions, because they were thus enabled to reduce their numbers by one-half and the resulting cells could pass more readily into a resting stage because of the greater density of the protoplasm. Finally the mixing of chromosomes in conjugation had an influence on hereditary transmission. Conjugation then is a purposeful process and an advantage to the individual. The habit is acquired and developed like any other instinct. It becomes a protoplasmic memory, an hereditary character.

As stated above, outside of the brown and red algae there is only a temporary association of the double number of chromosomes in the lower green plants, and there seems to have been a gradual development of the diploid sporophyte in the higher plants not because of the advantage coming from the greater number of chromosomes but because the sporophyte happened to acquire the habit of being nourished by the parent gametophyte in its embryonic condition. In some of the red algae where both generations start as independent individuals the sexual and nonsexual generations are practically alike in appearance and complexity of structure.

Wherever a sexual process is established a reduction division must also occur in the life cycle. The reduction may take place at three different stages. First, at the germination of the zygote; second, just before the formation of the gametes; or third, where an antithetic alternation of generations is present, just before the formation of the nonsexual spores on the sporophyte.

In the evolution of sex, it was the gametes which were first differentiated, both being produced on an hermaphrodite individual in nearly all the lower multicellular forms. As is well known, a decided sexual dimorphism appears in the gametes and often also in the sexual organs. The egg is large, stationary, and with an abundant food supply. The sperm is comparatively small, active and with a minimum of food stored in its body. The first evolution or differentiation of sexuality is then an expression of difference in nutritive qualities. Now what is the hereditary apparatus that determines that the incipient gametes shall develop as eggs in one part of the body and as sperms in another part? As stated, the reduction in most of the lower forms takes place at the germination of the egg spore. The cause then which determines the development of gametes of one kind or the other in the hermaphrodite body is a matter of the becoming active or latent of characters common to all parts of the organism. It is not at all the case that the sex of the gametes is determined by the association or disassociation of an x or a 2x number of chromosomes. It is a process similar in character to that which determines that one leaf shall be a foliage leaf and the one next to it a sporophyll; or that one branch shall continue as a vegetative shoot and the other one develop as a flower.

SEXUAL DIMORPHISM.

If we are right in assuming that the difference in gametes is an expression of a difference in nutritive function and that the advantage of heterogamy is one merely of specialization in the two cells, we may next inquire as to the probable cause of a difference in the size, shape, color, etc., of the ovaries and spermaries, and finally of the unisexual individuals in the higher forms.

In such plants as Vaucheria the difference in shape and size of the gametangia is remarkable, when the simplicity of the other parts of the plant is taken into consideration. Whether this difference is merely an expression of the activity of different hereditary characters set free by the determination of the sex of the part, we may not be able to discover. But it is certainly apparent that the sexual differentiation is brought about like any other differentiation in the growth of the hermaphrodite individual. The sexual dimorphism of the parts is of no special significance. The twist in the antheridium does not appear to be of any special advantage; for it does not result in bringing about the discharge of the sperms in any constant direction in respect to the oogonium. In Chara, the oogonium and antheridium are exceedingly complex and also remarkably differentiated in shape, size, and finally in color. The oogonium is green corresponding to its further nutritive function in ripening the oospore which becomes packed with food material, while the antheridium is a bright red. Whatever purpose the bright red color of the antheridium may have, it is not the result of any sexual selection. If it has any significance, that significance is purely physiological and is probably an expression of internal activities closely bound up with the nutritive hereditary tendencies which produce the male gametes.

In certain species of Oedogonium the plant produces eggs and the so-called androspores. These androspores produce dwarf males whose sperms fertilize the eggs of the original parent plant. Now, these dwarf males are of peculiar shape and size. There is thus a very striking sexual dimorphism produced here apparently by the fact that the androspores are very small spores when compared with those which produce the egg-bearing plant. Indeed the androspore appears to be a modified spermatozoid which developing parthenogenetically produces a stunted individual with male sexuality.

When one goes into the higher groups where unisexual individuals appear in species whose close relatives are hermaphrodite, one occasionally has a most striking sexual dimorphism between normal males and females. Thus in species of the common mosses belong to the genus Polytrichum the sexual branches are not only distinguished by having terminal scales of a different shape and size, but the female is entirely green while the tip of the male plant in which the antheridia are hidden is red. In the Liverwort, Marchantia, the difference in shape of the branches which bear the sexual organs is also very great but there is no difference in color.

The Heterosporous Pteridophytes show an extraordinary difference in the size of the sexual individuals and the same condition exists in most of the Gymnosperms. Finally, in the Angiosperms, when one meets with a dimorphism of the sporophytes, there is often a decided difference in the color of the flower-clusters; as in the common cottonwood where the carpellate catkins are green and the staminate ones red. At the time of blooming, therefore, there is a great contrast in the appearance of the two individuals. Examples like this could be multiplied indefinitely. It is sufficient to repeat again that similar developments and dimorphisms appear whether the sexual organs or branches are borne on unisexual or hermaphrodite individuals. It has commonly been assumed that the sexual dimorphism of the higher animals arose through sexual selection, either through a preference shown by the male or the female or both for some pattern or color. Evidently such an explanation to the similar phenomena observed in many plants would be the extreme of absurdity whatever one may think of its fitness as an explanation of sexual dimorphism in the intelligent animals.

I believe that sexual dimorphism or polymorphism whether of the sexual organs themselves or of sexual individuals is fundamentally of the same nature as vegetative dimorphism. There is nothing more extraordinary in the difference between male and female or between the staminate and carpellate flower of a monœcious plant than there is in the vegetative dimorphism to be seen in such plants as the Mermaid-weed (Proserpinaca palustris), Bidens beckii, or other similar forms. The same phenomena are seen in the change of a root to a shoot or vice versa. Root and shoot hereditary characters are present in both parts but only one group is active under a given set of conditions.

SEX RATIO.

We are wont to assume that the ratio of the sexes is about equal and this seems to be the case in the higher animals. For some plants, however, it is very wide of the mark. Take for example the gametophytes of Selaginella kraussiana: every cone produces one megasporophyll and about 18 microsporophylls. The number of microsporophylls varies somewhat. Now normally each megasporophyll produces four megaspores all from one megasporocyte. There are several megasporocytes but one destroys the others in its development. In the microsporangia, on the other hand, there are numerous microsporocytes each of which produces 4 microspores. The ratio between the spores is therefore 4: 18x4n, n representing microsporocytes. Roughly speaking the ratio is sometimes as high as 1:5000. Since the megaspores produce females only and the microspores males only, the ratio of the spores is also the ratio of the gametophytes coming from them. Now this ratio, as will appear later, is fixed by some process which takes place in the nuclei of the sporophyte during vegetative growth before the reduction division has been accomplished.

In the case of the staminate and carpellate sporophytes of the common hemp, the following condition has been found by ordinary statistical methods. Hayer discovered by examining 40,000 plants of Cannabis that there were 100 staminate to 114.93 carpellate individuals; Haberlandt in Austria found the ratio in the same species to be 100 staminate to 120.4 carpellate plants; while Fisch counting 66,000 plants at Erlangen found a ratio of

100 staminate to 154.24 carpellate individuals. Noll in experiments with hemp found that the percentage of staminate and carpellate offspring derived from the seeds of a single plant varied materially from the normal ratio whatever that may be. In some extreme cases only 10% were carpellate, in others 90% were carpellate. He concluded that the egg does not determine the ratio, otherwise there would not be such extreme variation. Then he crossed individual carpellate plants with pollen from a single anther with the result that the ratio of the offspring showed a very close approximation to the normal. A plant crossed with pollen from a single anther produced 100 staminate to 117.3 carpellate offspring while a plant crossed with pollen from a single inflorescence produced 100 staminate to 121.6 carpellate offspring. Noll concluded from these experiments that the ratio of staminate to carpellate plants in the offspring is determined by the sperm in the pollengrain and not by the egg. But I fail to see any evidence whatever for such a conclusion; even were the ratio 1:1 in the first case and 1:1.5 in the second. If the ratio is determined by the sperm, why should there be any difference in behavior between pollen taken from one anther and pollen taken from an indefinite number of anthers from various individuals, when a certain per cent. of the pollengrains from each anther is supposed to contain the male determining characters and the remainder the female? So far as we know the cell changes in all the anthers is essentially the same. There is nothing in fact on which to establish a case, for the ratios Noll determined in his experiments are far within the ratios obtained in nature by the statistical method. If the difference obtained proves anything at all, which is very doubtful, it shows merely that the sperms or eggs of some individuals or some flowers are more prepotent than others. In the case of the hemp, all we can say at present is that the ratio between staminate and carpellate plants seems to be exceedingly variable. The sex tendency may be so evenly balanced that some small external or internal factor may determine the condition. Thus under a normal environment the ratio should be rather constant in the numbers of carpellate and staminate plants.

In the pine which is monœcious, the staminate cones are greatly in excess of the carpellate and the enormous difference in the number of male and female gametophytes is again, as in Selaginella, determined by the spores which in turn are predetermined in the floral branches. For normally all the sporophylls of a cone are of one type. Here then the future sex is determined even in the incipient flowers from their very nature and position on the branch. In rare cases the determination may not be complete. Part of the cone may be carpellate and part staminate as reported by Fischer. Here the fixing of the sex tendency was evidently delayed to a later stage than usual.

In the flowers of the higher plants, the organs which produce the spores in which the sex of the gametophyte is determined are sometimes variable and sometimes constant. In the lower forms the numbers are usually exceedingly variable, as for instance in Sagittaria latifolia. In the more highly developed forms the numbers are very constant as in a lily where there are nearly always six stamens to three carpels. Since the males produced in a stamen are fairly constant in number and also the females in the carpels the sex ratio of the gametophytes would be 6 x males: 3 y females, x being a much larger number than y.

The ratio of Selaginella kraussiana has been given above. On some Selaginellas as S inaequalifolia, according to the illustrations, the number of microsporophylls and megasphorophylls seems to be about equal. Here then the proportion of females to males produced must be much larger than in S. kraussiana, provided the microsporangia produce approximately equal numbers of spores in the two species. Selagnellá rupestris, according to Miss Lyon, produces strobili or cones on the new vegetative shoots in late summer and autumn. Only megaspores develop that season and in these the gametophytes reach the stage bearing archegonia. In the spring the cones resume their special growth and the first microspores appear. Thus each cone has a basal zone of megasporangia, approximately six months old, and above it a narrow region of microsporangia. The number of microsporangia appears to be strictly limited, usually 8-12. Thenceforth so long as the cone continues to grow during the remainder of that season megasporangia only are developed. Here then sex determination goes parallel with the seasons. And it is interesting to note that male and female producing spores are developed in much the same way as the alternate zones of sporophylls and foliage leaves in some Lycopods.

These examples show that sex determination goes on without any reference to a reduction division or to the segregation of sex-determining bodies. Either directly or indirectly the control of sexuality may be dependent on the seasonal environment in exactly the same way as foliage leaves and scale leaves are determined in harmony with seasonal conditions on a woody twig.

SEX CONSTANCY.

In some organisms, it does not seem possible to change the sex by any known manipulation when once determined. So long as the individual continues, either directly or through vegetative propagation the sex remains the same. This has been found to be the case in the gametophytes of Marchantia for example. In these gametophytes the haploid number of chromosomes is present and they are always strictly male or female. In related Bryophytes the gametophytes, also with the haploid number of chromosomes, are hermaphrodite. Therefore the haploid and diploid, or the x and 2x, condition of chromosomes has nothing to do primarily with the determination of the sexual condition. And because the sexual condition cannot be changed means no more in the given case than that certain leaves have lost the power of reproduction while others have not. There is no structural difference in the hereditary apparatus so far as our cytological knowledge goes but only a difference of conditions.[1] The latency of the opposite hereditary tendency is to all appearances complete.

In some ferns the gametophytes, normally hermaphrodite, can be kept as males or females by a proper control of the environment. In Equisetum arvense, the gametophytes are unisexual, the male gametophytes are the smaller while the larger females are also more branched. There is thus a normal sexual dimorphism of the vegetative body. The thalli are influenced to a certain extent by external conditions and unfavorable conditions of nutrition tend to increase the proportion of males. But what is still more important, it has been demonstrated that Equisetum thalli which have developed ovaries, namely developed as females, can by insufficient nutrition be forced to produce spermaries. It is evident, therefore, that the thalli have not developed unisexually, as male or female, through some inherent difference in their constitution nor through the loss of male or female sex determining characters, but rather that one set of tendencies has become latent while the opposite set is active. The latency is however not permanent but can be overcome by a proper environment.

E'. and E'. Marchal have shown that in certain mosses, Barbula unguiculata. Bryum argentium, and Ceratodon purpureus, the gametophytes are strictly male and female and are produced in equal numbers from the spores of one sporangium. Now these mosses may regenerate secondary protonemata from fragments of the gametophyte, stem, scale or rhizoid, and in every case the sex character is faithfully continued. The sex could not be changed by varying the conditions of environment. By regenerating parts of the sporophyte which has the diploid number of chromosomes the Marchals obtained protonemata which are hermaphrodite rather than unisexual as those produced from the spores or gametophytes. The great majority, however, showed only male characters and a few developed only female characters. But the one sex was only latent as was shown by the possibility of obtaining hermaphrodite individuals again from these diploid, unisexual forms.

Now it is evident that two interpretations may be made of these phenomena. First, the spore gametophytes which were apparently unisexual contained the characters of both sexes, one set being latent; second, the hereditary characters of one sex only were present. The Marchals adhere to the second hypothesis. Were this the condition of things generally, one might agree with the conclusion, but since we have exactly the opposite condition in the Pteridophytes the hypothesis is probably incorrect even for the cases where it seems to fit. And certainly the production of some unisexual individuals among the abnormal gametophytes developed from the sporophyte, notwithstanding the fact that both sex tendencies were present and should have produced hermaphrodites, clearly points to the simpler explanation, namely, that the unisexual condition in both cases was brought about in the same way. To my mind the experiments indicate just the opposite from the conclusions drawn. If all the diploid individuals had been hermaphrodite the case would have been somewhat stronger. Even then the hypothesis would not necessarily follow that male and female hereditary characters were separated by the reduction division. For reduction might be merely the cause of the latency of one tendency or the other in chromosomes possessing both qualities.

As stated, in the homosporous pteridophytes the haploid gametophytes are mostly hermaphrodite, so it is certain that no sexual tendencies are segregated in reduction. Now is it not self-evident that in haploid hermaphrodite gametophytes at least so far as the evidence goes at present, both maternal and paternal sets of chromosomes have similar hereditary characters? Are not sexual peculiarities for the most part simply modifications in development of the general hereditary characters of the body which may produce a male-like, a female like, or a neuter-like type of structure depending on certain conditions of internal or external environment. Even Wilson, who has probably gone farthest in finding a specific difference between male and female insects, says that male and female are but relative terms. One need only recall the influence of emasculation on some of the higher animals to be convinced how important some more or less remote influences may be in determining the development of secondary sexual characters.

There are few plants that are strictly dioecious. In the willows and mulberries for example the sporophytes are frequently bisphorangiate. In all such plants therefore the hereditary characters are present which are able to produce the staminate or the carpellate condition or both on the same individual.

In most of the monœcious and diecious flowers also there are some vestiges of the opposite set of organs. The gametophytes of heterosporous plants are however all strictly unisexual The nature of the spore determining the condition definitely and this unisexuality is produced entirely apart from the reduction division.

In Salix petiolaris, Chamberlain found microsporangia growing in the ovulary of the carpel. In the microsporangia borne inside of the ovularies the microspore development was sometimes normal, but was as often feeble and abortive. In ovularies which contained microsporangia, the ovules were sometimes orthotropous, and had the integument developed all around.. The megaspore development was normal and embryos were not uncommon. Now this is certainly an important case, for it shows that even in the very organs differentiated to produce the one or the other set of spores, the hereditary characters are not always completely controlled. Something overcomes the dominance of the characteristic tendency and thus permits the opposite tendency, which has no phylogentic basis in the hereditary characteristics of the organ, to come to expression. But this is after all no more remarkable than many other vegetative expressions, as stamens changing to petals, leaf-blades of Botrychiums developing as sporophylls, and many other peculiar developments that might be mentioned.

One of the most interesting cases on record in the change of the sexual condition is that of the tropical papaya (Carica papaya). This is a dioecious species but it has been found that if one of the staminate and therefore unfruitful trees has its terminal bud removed it soon begins to produce carpellate fruits.

This experiment suggests that there may be many methods of manipulation, which might be employed for changing the sexual condition, that have not yet been tried on favorable subjects.

Braem reports a somewhat similar case for a worm.

Ophryotrocha puerilis is usually unisexual but occasionally hermaphrodite. Braem halved a female with ripe eggs. The head portion with 13 segments was isolated and in three weeks it had regenerated 7 segments. The ova had disappeared from the gonads and a functional spermary had developed which was producing spermatozoa. Braem thinks that the very young indifferent germ cells had developed as male cells in consequence of the amputation. There was no trace of hermaphroditism. It is certain, therefore, that the gonads changed from an egg-producing to a sperm-producing tissue.

In dioecious plants also where some of the imperfectly carpellate individuals have bisporangiate flowers, poor nutrition, induced by various causes, lessens the proportion of bisporangiate flowers. Correns found that in Satureia the production of a greater or less number of carpellate or bisporangiate flowers is dependent upon nutrition in its widest sense, notwithstanding that he believes sex is determined in Mendelian ratio.

All the known facts clearly indicate that various external and internal conditions, are able to influence the *expression* of hereditary characters, although they may not affect the *transmission* of characters. This has lately been emphasized by O. F. Cook.

Differences of heat, light, food, chemicals, and internal secretions are known to induce changes in the expression of characters. The necessary presence of the thyroid gland in man, the presence of the spermaries in the higher animals, the influence of gall producing organisms on the higher plants, the effect of scions on the character of the roots on which they are grafted, all show how expression of hereditary characters can be changed in the individual. A remarkable fact in support of the proposition that the morphological expression of sexuality is the result of a condition is presented by the known cases of sterile female birds which sometimes take on the male plumage. All these phenomena appear to indicate that sexual characters are a common inheritance, there being no female hereditary characters as such nor male characters, but general characters which may be expressed in one form or another during development from the egg on up to the death of the individual.

TIME OF DETERMINATION OF THE SEX OF THE INDIVIDUAL.

Nothing in biology is more definitely established than the fact that there is no definite or special time common to all organisms at which the sexuality of the individual is determined. It may be in the vegetative cells before the sporocytes are produced, in the development of the sporocytes themselves, in the daughter cells of the sporocytes, or at some later stage. In the case of organisms with the diploid number of chromosomes, the sex may be determined in one of the gametes before fertilization, and for the individual, therefore, at the time of fertilization, or in certain species at some subsequent time.

In speaking of the determination of sex, one must not forget that there are a number of types of sexual individuals,—namely, haploid males, females, and hermaphrodites; diploid males, females, and hermaphrodites; and of heterosporous sporophytes there are diploid microsporangiate, megasporangiate, and bisporangiate individuals. Through parthenogenesis there are possibly also haploid microsporangiate, megasporangiate, and bisporangiate individuals. In all critical discussions these different categories must be clearly distinguished before generalizations can be made.

Recently the opinion has several times been expressed that it is wrong to compare hermaphrodites which have in a given case developed but one sex with what are supposed to be true unisexual forms. But the stand does not seem to be well taken. We have all gradations between normal hermaphrodites and true unisexual gameophytes as well as between bisporanglate and monosporangiate sporophytes. Many of the discussions on sex-heredity are confused because the authors fail to recognize the logical homologies between sexual and nonsexual plants and animals. The most common mistake along this line is in regard to the haploid gametophyte generation which has no clear homolog among the animals. The same confusion exists in regard to the reduction division. Many are not able to get beyond the erroneous idea that the reduction division must in some way be a maturation division when in most plants it has nothing whatever to do with the development and ripening of gametes.

But to return to the question of sex determination; in Isoetes, according to Smith, each leaf bears but one sporangium and the sporangia are apparently all alike in the early stages. Up to the time when the archesporium is 8 to 10 cells deep in cross section there is no histological feature by which one may determine whether a given sporangium will produce microspores or megaspores. The first changes to be seen that mark the microsporangium are those which lead to the differentiation of the sporocytes. The sex of the future gametophytes is, therefore, determined in the early stages of the sporocytes if not earlier. The nature of the sporophylls of Selaginella kraussiana must be determined in the incipient stage, for the one megasporophyll always has a definite position in relation to the numerous microsporophylls.

As far back as 1881, Prantl found that if fern thalli are cultivated with aboundant nutriment, only ovaries are developed, while with poor nourishment spermaries are formed. The sex of these potentially hermaphrodite juvenile individuals is thus determined by their environment during vegetative growth. Moreover, by keeping them in suitable conditions they may be kept as male and female, the ordinary hermaphrodite tendencies never coming to expression.

Douin finds that in the unisexual liverwort, Sphaerocarpus terrestris about 75 per cent. of the spore tetrads clearly show two males and two females. There were, however, several cases clearly anomalous. One group of two tetrads had five males and three females. Another tetrad had three males and one female, and two others had one male and three females. Apparently the sex in this plant is determined at the time of the reduction division. But I do not think that the 75 per cent. is high enough to warrant a final conclusion. At least 90 per cent. of the tetrads should be taken into account before one could make any decided claims. But it may well be that the sex is determined at the first division without any definite shifting of hereditary characters. The anomalous cases can also be explained as examples of abnormal latency or activity. Probably with a large number of cultures properly controlled, one could find tetrads giving rise to all males or all females. One can simply say that in Sphaerocarpus sex determination is usually coincident with reduction. To say that it is caused by a definite segregation during reduction of male and female hereditary units is another proposition. Closely related Bryophytes are hermaphrodite after reduction. It must be clearly kept in mind that when plants finally developed a condition of complete unisexuality in the heterospores groups it was accomplished without any reference to a segregation in the reduction division. This is the one great fact that stands out most prominently. The final evolution of a definite sex determining process was accomplished independently of the reduction division and therefore independently of any known segregation of material hereditary units or determinants. Maternal and paternal chromosomes do not determine sex whatever determining factors may be present, the only visible and known difference in the male and female producing microspores and megaspores of higher plants is a difference in size of the cell together with a difference in the amount of cytoplasm and included food materials. If it can be shown that sex is determined independently of reduction in a large number of cases then it is reasonable to demand that the opposite assertion be established with indubitable proofs.

Not only does the double or single number of chromosomes appear to have nothing to do with sex determination, but according to Yamanouchi, the apogamously produced sporophyte of nephrodium, which shows constantly the x or gametophytic number, looks like the ordinary 2x or diploid sporophyte, resulting from fertilization. It is evident, therefore, that the single or double number has little influence upon the general appearance of the plant. The conclusion follows that both the maternal and paternal chromosomes have all the ordinary hereditary units of the species. And since it is known that paternal and maternal equivalents conjugate in the formation of the bivalent chromosomes, it follows that no difference how the univalents are segregated, each daughter nucleus will still have all the types of true chromosomes and so the complete inheritance of the race, including sexual tendencies.

If one thinks of organisms as continuous developments from generation to generation and each individual as a branch from the main axis of progression, then sex in most cases becomes simply an individual expression of a more general inheritance, in many cases even an alternative expression when female determining cells give rise to males or vice versa. The alternative expression is then probably of the same nature as alternative expression in the formation of leaf and flower shoots in a branching plant.

SEX PRODUCING NUCLEAR BODIES.

In a large number of insects belonging chiefly to the Hemptera and Coleoptera a definite chromosomal difference has been found between the male and female. The "accessory chromosomes" or allosomes are so distributed at the time of the reduction division that all the eggs are alike while the sperms are of two kinds. The chromosome group of one of the two types of sperms is like that of the egg, and when such a sperm fertilizes an egg a female zygote is produced. The other type of sperm has a chromosome group unlike that of the egg and produces a male zygote in fertilization. An attempt has been made to find similar peculiarities in plants but so far without success. I shall touch but briefly on the presence of these sex-determining bodies as discovered by McClung and worked out for many species by Stevens, Wilson, Montgomery, Morgan, and others. These "accessory chromosomes," "idiochromosomes," or allosomes as Montgomery calls them are said generally to arise from or to be closely connected with a chromatin nucleolus. Now in plants, at least in all cases where the objects are of such size and distinctness as to warrant definite conclusions, the chromosomes come from the chromatin network. If then the allosomes are a type of body related to the nucleolus, we may regard their presence as influencing nutritive functions and in some such way controlling sex. If the allosomes are not derived from the chromatin network they need not be considered as special bearers of hereditary characters. They may be put in the same category as nucleoli, centrosomes, plastids, etc. Their presence may have an influence on the chromosomes in making latent or setting free certain hereditary peculiarities which control sexual development. We can, with all the evidence so far brought to light, still say that maleness or femaleness is a condition and not a simple character. Nevertheless the presence of such bodies is an exceedingly interesting biological fact.

According to Wilson the known cases of sexual differences of chromosome groups, where allosomes or "idiochromosomes" are present, fall into five classes as follows:

1. "Both sexes with the same number of chromosomes, a pair of equal idiochromosomes present in both. No visible difference between the two classes of spermatozoa or between the male and female somatic groups."

2. "Both sexes and both classes of spermatozoa with the same number of chromosomes; the male with a pair of unequal idiochromosomes, half the spermatozoa receiving the large one and half the small one."

3. "The female chromosome group with one more chromosome than the male. The male with an unpaired idiochromosome and an odd spermatogonial number, half the spermatozoa receiving the idiochromosome and half being without it."

4. "Female group (by inference only) with two more chromosomes than the male. In the male a pair of unequal idiochromosomes, half the spermatozoa receiving both these idiochromosomes, and hence two more than the other half."

5. "Female group with three more chromosomes than the male. Half the spermatozoa receiving three more chromosomes than the other half."

Wilson is very careful to say that the two kinds of spermatozoa are female— and male-producing and not female— or male-determining.

The allosome appears to be one of a number of external and internal influences which accomplish sex determination, and it is probable that this influence is brought about either directly or indirectly by a stimulus on the hereditary apparatus, the result of the stimulus showing itself in large and small spores, large and small gametes, or male and female individuals.

But great caution must still be taken lest we be led away by this seemingly clear case of sex-producing bodies in the gametes of insects and other animals. The difference may after all be only a coincidence to the sex-determining factor, and this really appears to be the case according to some recent investigations by Morgan. In the phylloxerans which are gall-insects of the hickories, the fertilized eggs produce only females. This results because only functional female-producing spermatozoa are formed — the male-producing sperms degenerating. The females that result from the fertilized eggs produce subsequently both males and females parthenogenetically. Without going into the complicated history of the development of the various generations in the life cycle a few prominent facts may be pointed out. In the two species, Phylloxera fallax and P. caryaecaulis, male eggs and female eggs are determined as such before there is any loss of chromosomes. The total number of chromosomes is present, yet one egg is large and the other small. The preliminaries of sex-determination for both sexes go on in the presence of all the chromosomes. The large eggs produce females, the small males. The male animal itself is produced only after the elimination of two of the chromosomes, but the sexual female and the parthenogenetic female are both produced in the presence of all the chromosomes. It is apparent that we have here something like in the heterosporous plants. Sex is determined before the reduction division and the two sizes of eggs are significant when compared with microspores and megaspores. In Phylloxera caryaecaulis a large preponderance of male producers are developed. When it is recalled that all the descendants can be traced to a single egg fertilized by a "female-producing" sperm the results are very significant. Either external conditions determine the result or else there is a strong "prepotency" of the egg or sperm in one or the other direction. Certainly these gall-insects show that the allosomes are not sex-determining bodies per se and this is still further established by the fact that the division into male and female layers takes place one generation prior to the formation of the sexes. The evidence which Morgan thus gives from the animal side is in complete agreement with that presented by the heterosporous pteridophytes. We must at present, therefore, regard the allosomes as sex-indicating rather than sex-determining or sex-producing bodies.

SPECIAL VIEWS REGARDING SEX-INHERITANCE.

Guyer reports that pheasant hybrids are almost all males and suggests that their sex is due to incompatibility of the germ plasms. The known hybrids resulting from a crossing of guinea fowls and ordinary chickens are also all males. He says that in the case of hybrids and particularly those from widely separated parents, there would in all probability be more or less default in the metabolic processes because of the incompatibilities which must necessarily exist between two germ-plasms so dissimilar.

Kauffman studied the water molds, Saprolegniaceae, with especial reference to the variations of the sexual organs. He holds that sexuality can be controlled by external conditions.

Maud and Raymond Pearl made a statistical study based on 200,000 births in Buenos Aires. They show that there is a markedly greater preponderance of male to female births in children born of parents of different races. This seems to be in agreement with the results obtained from hybrid pheasants.

Among botanists, Strasburger, Correns, and Noll believe that the egg tends to produce females. If this were really the case, the reduction division could have nothing to do directly with sex-determination in the heterosporous plants, since no allosomes are known to be present and the eggs are vegetative descendants of spores produced through reduction. But on the other hand, they think that the reduction division in the microsporocyte separates male tendencies of unequal vigor so that in dioecious plants two microspores of a tetrad will give rise to male gametophytes with sperms which in fertilizing the egg are prepotent over the female tendency and so will produce staminate plants; the other two microspores will give rise to gametophytes whose sperms are not able to overcome the female tendency of the egg and hence will produce carpellate plants.

Correns supports his hypothesis by results obtained through studies of Bryonia dioica and other plants. He believes that the egg always carries the same sex tendency, namely to produce females are more properly speaking carpellate plants, while the sperms are of two kinds, half bearing the female and half the male (staminate) tendency. The male tendency dominates over the female. The females are therefore, homozygous (female + female) with respect to sex; the male are heterozygous (female + male) with respect to sex. In other words, the female is a homozygous recessive while the male is a heterozygous dominant. But if the observations on bees are correct, then the egg must have the male tendency; for all parthenogenetic developments among the common honey bees result in males.

According to Castle, the female is the male condition plus something else, i. e. a distinct unit character Mendelian in heredity. Maleness is not, then, the Mendelian allelomorph to femaleness, but a differential factor between male and female is allelomorphic to absence of that factor. Presence of the factor then means femaleness, absence of it means maleness. The differential factor is supposed to be inherited as a Mendelian character dominant over its absence. But it must be remembered that both sexes develop peculiarities absent in the other and the male has usually more than the female. The sex determination simply causes one or the other set of peculiarities to appear.

Castle concludes among other things that sex is not directly controlled by the environment but is determined by internal (gametic) factors. But this does not harmonize with the facts presented by the homosporous and heterosporous pteridophyte gametophytes. Castle's further statement that the determination of sex depends upon the presence in the zygote of a factor or factors which are inherited in accordance with Mendel's law cannot hold for the heterosporous pteridophytes, for the zygote produces a bisporangiate plant and the sex of the gametophyte is determined independently of the reduction division not in a Mendelian ratio but in some species in the proportion of 5,000 males to one female.

According to Wilson, the eggs are all alike, while the spermatozoa are of two sorts half bearing the same character as the eggs and half being without it. But Bateson and his associates find that in the moth Abraxas grossulariata and in a canary bird studied by them, the eggs are dimorphic in sex tendency whereas the spermatozoa are all alike.

The apparently antagonistic results brought to light are really only antagonistic when viewed from the standpoint of the several contradictory hypotheses of sex-determination. If we take a reasonable view of sexual inheritance, regarding it as a common inheritance of the race which may express itself in one way or the other, as ordinary vegetative characters, the peculiarities presented will be readily explained on the same basis as the various vegetative polymorphisms to be found in the higher plants, the play of hereditary factors and the result of hereditary expression being much greater than what is shown by Mendelian inheritance.

GENERAL CONCLUSIONS.

The principles maintained in the foregoing discussion are either based on or lead to the following general conclusions and hypotheses:

1. Every cell of an organism contains all the general hereditary characters or units of the entire individual body.

2. Only a part of these characters come to expression at any given stage of development.

3. Some hereditary characters are common to all the organs or parts of the hereditary apparatus, others to individual chromosomes.

4. Peculiarities of form and function come to expression by the combined activity of groups of cells as well as by the

activity of chromosome groups, of individual chromosomes, or of smaller heredity-bearing units.

5. Hereditary tendencies may be dominant or recessive in respect to each other; they may be dormant or active through the influence of environment; or they may work together or influence one another in such a way that a strange or new structure appears.

6. Sexuality expressed as maleness or femaleness, whether in gametes, sexual organs or individuals is a condition and not a character, and the development of a cell as an egg or a sperm does not destroy its power later, parthenogetically, to produce the opposite sex.

7. Fertilization was primarily not a stimulus to further growth; conjugation was primarily not a mode of reproduction, nor was sexuality primarily developed as a means to variability.

8. Sex may be determined sometime before reduction and thus independently of any process going on during either a vegetative or reduction karyokinesis; it may be determined during the reduction division; it may be determined during the fertilization stage; or finally it may be determined after vegetative growth has begun.

9. In some cases, when the sex is once determined it cannot be changed in the vegetative body nor in any negative spore or propagative bud; in other cases, it may be changed in the vegetative body after being developed as male or female.

10. The sexual ratio is not Mendelian in the gametophyte and apparently not in the sporophyte.

11. The most prominent fact in the differentiation and evolution of unisexual gametophytes in the higher plants is that although the entire mechanism of reduction was well developed, nevertheless the separation of the sexes was accomplished entirely independently of reduction by a differentiation of large, female-determining, and minute, male-determining spores.

OHIO ACADEMY OF SCIENCE PUBLICATIONS

First and Second Annual Reports............Price 30 cts. each
Third and Fourth Annual Reports...........Price 25 cts. each
Fifth to Sixteenth Annual Reports..........Price 20 cts. each
Seventeenth Annual Report ....Price 40 cts. each

SPECIAL PAPERS.

1. "**Sandusky Flora.**" pp. 167. E. L. Moseley..........60 cts.
2. "**The Odonata of Ohio.**" pp. 116. David S. Kellicott.60 cts.
3. "**The Preglacial Drainage of Ohio.**" pp. 75. W. G. Tight, J. A. Bownocker, J. H Todd and Gerard Fowke ....50 cts.
4. "**The Fishes of Ohio.**" pp. 105. Raymond C. Osburn.60 cts.
5. "**Tabanidae of Ohio.**" pp. 63. James S. Hine.......50 cts.
6. "**The Birds of Ohio.**" pp. 241. Lynds Jones........75 cts.
7. "**Ecological Study of Big Spring Prairie.**" pp. 96. Thomas A. Bonser ....50 cts.
8. "**The Coccidae of Ohio, I.**" pp. 66. James G. Sanders ....50 cts.
9. "**Batrachians and Reptiles of Ohio.**" pp. 54. Max Morse ....50 cts.
10. "**Ecological Study of Brush Lake.**" pp. 20. J. H. Schaffner, Otto E. Jennings, Fred J. Tyler..35 cts.
11. "**The Willows of Ohio.**" pp. 60. Robert F Griggs....50 cts.
12. "**Land and Fresh-water Mollusca of Ohio.**" pp. 35. V. Sterki ....50 cts.
13. "**The Protozoa of Sandusky Bay and Vicinity.**" F. L. Landacre ....60 cts.
14. "**Discomycetes in the Vicinity of Oxford, Ohio.**" pp. 54. Freda M. Bachman ....50 cts.
15. "**Trees of Ohio and Surrounding Territory.**" pp. 122. John H. Schaffner ....75 cts.
16. "**The Pteridophytes of Ohio.**" pp. 41. John H. Schaffner ....50 cts.

Address: W. C. MILLS, Librarian, Ohio Academy of Science, Page Hall, Ohio State University, Columbus, Ohio.

Proceedings

of the

Ohio State Academy of Science

VOLUME V, PART 8

Annual Report

Twentieth Meeting

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume V, Part 8.

Annual Report

of the

Ohio State Academy of Science

Twentieth Meeting
1910

Organized 1891 Incorporated 1892

Publication Committee

J. C. Hambleton E, L. Rice Bruce Fink

Date of Publication, November, 1911

Published by the Academy
Columbus, Ohio

Officers---1910-1911

PRESIDENT.

L. G. WESTGATE.

VICE-PRESIDENTS.

CHARLES BROOKOVER. M. E. STICKNEY.

G. D. HUBBARD.

SECRETARY.

L. B. WALTON.

TREASURER.

J. S. HINE.

LIBRARIAN.

W. C. MILLS.

EXECUTIVE COMMITTEE.

Ex-Officio.

W. F. MERCER. JAS. S. HINE. L. B. WALTON.

Elective.

M. F. GUYER. E. L. MOSELEY.

BOARD OF TRUSTEES.

W. R. Lazenby, Chairman, term expires........................... 1912
E. L. Rice, term expires.. 1911
Frank Carney term expires....................................... 1913

PUBLICATION COMMITTEE.

J. C. Hambleton, Chairman, term expires..........................1912
Bruce Fink, term expires.. 1911
E. L. Rice. term expires...1913

Past Officers

PRESIDENTS.

1892.	E. W. Claypole,	1901.	A. D. Selby,
1893.	Edward Orton,	1902.	W. R. Lazenby,
1894.	F. M. Webster,	1903.	C. J. Herrick,
1895.	D. S. Kellicott,	1904.	E. L. Moseley,
1896.	A. A. Wright,	1905.	Herbert Osborn,
1897.	W. A. Kellerman,	1906.	E. L. Rice,
1898.	W. G. Tight,	1907.	Charles Dury,
1899.	G. F. Wright,	1908.	Frank Carney,
1900.	Joshua Lindahl,	1909.	J. H. Schaffner,

1910. W. F. Mercer.

VICE-PRESIDENTS.

1892. A. A. Wright, Ellen E. Smith.
1893. D. S. Kellicott, D. L. James.
1894. G. H. Colton, Mrs. W. A. Kellerman.
1895. H. E. Chapin, Jane F. Winn.
1896. A. L. Treadwell, Charles Dury.
1897. C. E. Slocum, J. B. Wright.
1898. Josua Lindahl, J. H. Todd.
1899. Chas. E. Albright, A. D. Selby.
1900. J. A. Bownocker, Lynds Jones.
1901. H. Herzer, Mrs. W. A. Kellerman.
1902. C. J. Herrick, C. S. Prosser.
1903. J. A. Bownocker, Miss L. C. Riddle.
1904. Lynds Jones, L. H. McFadden.
1905. C. W. Dabney, F. M. Comstock.
1906. Charles Dury, Lynds Jones.
1907. W. F. Mercer, Frank Carney.
1908. J. H. Schaffner, F. C. Waite.
1909. L. G. Westgate, S. R. Williams.
1910. M. M. Metcalf, Bruce Fink, G. D. Hubbard.

TREASURERS.

1892-95.	A. D. Selby,	1899-04.	Herbert Osborn,
1896-98.	D. S. Kellicott,	1905-11.	Jas. S. Hine.

LIBRARIAN.

1904-11. W. C. Mills.

SECRETARIES.

1892.	W. R. Lazenby,	1895-03.	E. L. Moseley,
1893-94.	W. G. Tight,	1904	F. L. Landacre,
1905-11.	L. B. Walton.		

TRUSTEES.

1900-04.	F. M. Webster,	1901-09.	W. R. Lazenby,
1900-02.	H. C. Beardslee,	1905-08.	G. B. Halsted,
1904-06.	C. J. Herrick,	1907-08.	Chas. Dury,
1900-05.	J. H. Schaffner,	1908-11.	E. L. Rice.
1910-12.	Frank Carney.		

PUBLICATION COMMITTEE.

1892-01.	F. M. Webster,	1901-03.	L. H. McFadden,
1892-97.	W. A. Kellerman,	1902-04.	Gerard Fowke,
1892-96.	E. W. Claypole,	1904-05.	Jas. S. Hine,
1897-99.	E. L. Moseley,	1905. -	E. L. Rice,
1898-00.	S. Belle Craver,	1906. -	J. C. Hambleton,
1900-08.	J. H. Schaffner,	1908. -	Bruce Fink.

Membership

AUGUST 1, 1911.

Life Member

McMillin, Emerson E............320 Riverside Drive, New York, N. Y

Active Members

Slocum, C. E.....................................218 13th St., Toledo
Aiken, W. H.....................................Station K, Cincinnati
Albright, Charles E.....................................Columbus
Armstrong, C. A., *Geology*.................1110 Chance Ave., Canton
Bachman, Freda M., *Biology*...............310 Bruen St., Madison, Wis
Badertscher, J. A., *Histology, Embryology, Physiology*..........Athens
Bales, B. R., *Ornithology, Entomology*......149 W. Main St., Circleville
Ball, E. D., *Entomology*...................................Logan, Utah
Barrows, William M., *Experimental Zoology*.....O. S. U., Columbus
Bell, Edith C., *Biology*...................................Mt. Vernon
Benedict, H. M.........................Univ. of Cincinnati, Cincinnati
Berger, E. W., *Zoology*...............................Gainesville, Florida
Blair, Kate R...............................1501 Neil Ave., Columbus
Bolin, W. C., *Engineering*.......352 Grand Central Station, Chicago, Ill.
Bownocker, John A., *Geology*.....................O. S. U., Columbus
Box, Cora May, *Zoology*..................Univ. of Cincinnati, Cincinnati
Braam, Maximilian, *Biology*...........Hughes High School, Cincinnati
Braun, Annette F., *Zoology*..............Univ. of Cincinnati, Cincinnati
Brockett, Ruth E., *Botany*.............................Rio Grande
Brookover, Charles..........................Buchtel College, Akron
Brugger, Harvey, *Botany*....................218 N. Wood St., Fremont
Bubna, Matthias, *Entomology*..........2629 Woodhill Road, Cleveland
Budington, R. A., *Zoology, Physiology*.........................Oberlin
Burgess, A. F., *Entomology*.........U. S. Dept. Ag., Washington, D. C.
Carney, Frank, *Geology*...................................Granville
Claassen, Edo., *Botany*...............18 Fernwood Ave., East Cleveland

CLARK, HOWARD, *Geology*. . . . . .Granville
CLEVENGER, J. F., *Botany*. . . . . .State College, Pa.
COGHILL, GEORGE E., *Zoology, Neurology*. .Granville
COLE, A. D., *Physics*. . . . . .Columbus
COLTON, GEORGE H. . . . . .Hiram
COMSTOCK, FRANK M., *Vert. Zoology*. . . . . .Case School, Cleveland
COTTON, E. C., *Entomology*. . . . . .Experiment Sta., Knoxville, Tenn.
COPELAND, W. F. . . . . .Athens
CRAMER, WILLIAM G., *Zoology*. . . . . .273 Southern Ave., Cincinnati
DABNEY, CHARLES W. . . . . .Univ. of Cincinnati, Cincinnati
DACHNOWSKI, ALFRED, *Botany*. . . . . .O. S. U., Columbus
DAVIES, CLARA A., *Botany, Physics*. . . . . .Granville
DAVIS, V. H., *Horticulture*. . . . . .O. S. U., Columbus
DAVIS, B. M., *Zoology*. . . . . .Oxford
DETMERS, FREDA, *Botany*. . . . . .O. S. U., Columbus
DICKEY, MALCOLM G., *Botany*. . . . . 1986 Indianola Ave., Columbus
DITTO, T. W. . . . . .Delphos
DOREN, JANE MACARTNEY, *Botany, Zoology*. . . . . .Bexley, Columbus
DURRANT, E. P., *Biology, Geology*. . . . . .Westerville
DURY, CHARLES. . . . . .537 Ridgway Ave., Cincinnati
DUTTON, C. F., JR. . . . . .4816 Franklin Ave., Cleveland
EDWARDS, E. H., *Zoology, Physiology*. . . . .
. . . . .7317 Clinton Ave. N. W., Cleveland
FEIEL, ADOLPH. . . . . .520 E. Main St., Columbus
FENNEMAN, N. M., *Geology, Geography*. . . .Univ. of Cincinnati, Cincinnati
FINK, BRUCE, *Botany, Zoology*. . . . . .Oxford
FISCHER, WALTER, *Botany*. . . . . .Para, Brazil
FISCHER, MARTIN H., *Experimental Medicine*. . . . .
. . . . .Univ. of Cincinnati, Cincinnati
FITZGERALD, A. D., *Histology, Pathology*. . . . . .Reynoldsburg
FLYNN, MAUD, *Zoology*. .338 W. Sixth Ave., Columbus
FOOTE, E. H., *Biology*. . . . . .812 S. E. Fourth St., Minneapolis, Minn.
FOX, CHARLES P., *Botany, Chemistry*. . . . . .395 Doyle St., Akron
FRANK, J. N., *Botany, Entomology*. . . . . .Colleton, S. C.
FULLMER, E. L., *Botany*. . . . . .Berea
FULTON, B. B., *Entomology, Botany*. . . . . .Newark
GARY, L. B., *Geology*. . . . . .263 Hoyt St., Buffalo, N. Y.
GIBBS, DAVID . . . . .Milan
*GOODRICH, CALVIN, *Conchology*. . . . . .Toledo Blade, Toledo
GROVER, F. O., *Botany*. . . . . .Oberlin

---

* Subject to ratification of the Society at the annual meeting, 1911.

Griggs, R. F., *Botany*.................................O. S. U., Columbus
Guyer, M. F...Madison, Wis.
Hambleton, J. C., *Botany, Zoology*...........212 E. 11th Ave., Columbus
Hansen, Mrs. Hermina J., *Biology*......Hughes High School, Cincinnati
Hathaway, Edward S., *Zoology, Botany*..Univ. of Cincinnati, Cincinnati
Hawk, J. F., *Biology*..................................Box 302, Lancaster
Hayes, Seth.......................................135 Center St., Dayton
Henninger, W. F., *Ornithology, Entomology*...............New Bremen
Herms, W. B.........................Univ. of California, Berkeley, Cal.
Herzer, H., *Paleontology*..Marietta
Hillig, Fred J............................St. John's College, Toledo
Himebaugh, Oscar, *Botany, Geology*..............................Akron
Hine, J. S., *Entomology, Ornithology*................O. S. U., Columbus
Holt, W. P., *Botany*...............................2113 Putnam St., Toledo
Hood, G. W., *Entomology, Horticulture*........57 W. 8th Ave., Columbus
Houser, J. S., *Entomology*......................................Wooster
Hubbard, G. D., *Geology, Physiography*..........................Oberlin
Hyde, J. E., *Geology*................School of Mining, Kingston, Ontario
Jackson, C. F., *Zoology*.......................................Durham, N. H.
James, C. B..Adelbert College, Cleveland
Jennings, O. E., *Botany*........Carnegie Museum Annex, Pittsburg, Pa.
Johnson, Dora E., *Botany, Physiography*..........................Medina
Jones, Lynds, *Ornithology*.....................College Museum, Oberlin
Judson, C. A., *Botany*.......................235 Columbus Ave., Sandusky
King, J. Lionel, *Botany, Entomology*..........................Cleveland
Knower, H. McE.........................Univ. of Cincinnati, Cincinnati
Krecker, Frederick H., *Biology*...................................Marietta
Lamb, G. F., *Biology, Geology*...............Mt. Union College, Alliance
Landacre, F. L., *Zoology*..............................O. S. U., Columbus
*Lantis, Vernon, *Botany*.....................2509 Ohio Ave., Cincinnati
Lazenby, Wm. R., *Horticulture, Botany*.............O. S. U., Columbus
Library, Ohio State University.....................................Columbus
Lindahl, Josua, *Zoology*..................5700 Peoria St., Chicago, Ill.
Livingston, A. E., *Zoology*..Athens
Lloyd, John Uri........................Court and Plum Sts., Cincinnati
Luginbill, Philip, *Entomology*..............................Lafayette, Ind.
March, Cora, *Biology*...Wyoming
Mark, Clara Gould, *Geology, Botany*................O. S. U., Columbus
Mather, Kirtley F., *Geology*....................................Granville
Mathews, Mary E...Painesville

* Subject to ratification of the Society at the annual meeting, 1911.

*McAvoy, (Miss) Blanche, *Biology*..............................
..............................Box 56, Sta. F, Foley Road, Cincinnati
McCall, A. G., *Agronomy*..........................O. S. U., Columbus
McCampbel, Eugene F., *Bacteriology*................O. S. U., Columbus
McCleery, Edna, *Botany*....................................Lancaster
McCoy, C. T., *Botany*..Lancaster
McCray, Arthur H., *Zoology and Entomology*..................Duval
McDaniel, J. E., *Biology*..............................Olathe, Colo.
McFadden, L. H., *Chemistry*....................40 Warden St., Dayton
McKean, T. L., *Botany*..Berea
Mead, Charles S., *Zoology, Botany*............Box 122, Suffield, Conn.
Mercer, W. F., *Biology*.........................Ohio University, Athens
Metcalf, C. L., *Botany, Zoology*..............86 E. 11th Ave., Columbus
Metcalf, M. M., *Zoology*.......................................Oberlin
Metcalf, Zeno P.....................................Raleigh, N. C.
Mills, W. C., *Archaeology, Biology*..................O. S. U., Columbus
Moody, A. E..Flushing
Morse, W. C., *Biology, Geology*......................O. S. U., Columbus
Moseley, E. L., *Zoology, Botany, Physiography*...............Sandusky
Nelson, James A., *Zoology, Embryology*..........................
..............U. S. Dept. Agricul., Div. Entom., Washington, D. C.
Nichols, Susan P., *Botany*.....................Oberlin College, Oberlin
Oberholser, H. C...........1444 Fairmont St. N. W., Washington, D. C.
Odenbach, F. L., *Meteorology*...........St. Ignatius College, Cleveland
Osborn, Herbert, *Entomology, Zoology*...............O. S. U., Columbus
Osburn, Raymond C., *Zoology, Ichthyology*......................
..............................Columbia Univ., New York, N. Y.
Oxley, Charles E., *Geology, Physics*........................Coshocton
Parkhurst, C. P., *Science*.......................9 W. Long St., Columbus
Peaslee, L. D., *Zoology*...................Univ. of Cincinnati, Cincinnati
Pickel, George J., *Chemistry*..............St. Ignatius College, Cleveland
Piwonka, Thomas..................226 Superior Ave. N. W., Cleveland
Prosser, C. S., *Geology*................................O. S. U., Columbus
Rice, Edward L., *Zoology*....................................Delaware
Roudebush, Lowell.......................R. F. D. No. 3, New Richmond
Royer, John S., *Biology*..Bradford
Rush, R. C., *Conchology*...Hudson
Sanders, J. G., *Entomology, Botany*........................Madison, Wis.
Schaffner, J. H., *Botany*...............................O. S. U., Columbus

---

* Subject to ratification of the Society at the annual meeting, 1911.

Scheffel, Earl R., *Geology*..............................Urbana, Ill.
Seaton, Miss F........................Central High School, Cleveland
Selby, A. D., *Botany*........................Experiment Station, Wooster
Shade, Ernest F., *Physiography, Botany, Physics*................Medina
Shatzer, C. G.........................Wittenberg College, Springfield
Shaw, N. E., *Entomology*.........................O. S. U., Columbus
Shilliday, C. L., *Zoology*....................................Athens
Sim, Robert J..Jefferson
Smead, Anna, *Biology*.........................624 Nestle St., Toledo
Smith, A. L...Valley Crossing
Smith, Ethel M...Rome
Smith, G. D., *Botany, Zoology*...........................Richmond, Ky.
Smith, J. Warren, *Meteorology*..............Weather Bureau, Columbus
Snearline, A. L., *Botany and Geology*..........................Akron
Snyder, F. D., *Zoology, Ethnology*..........................Ashtabula
Stair, L. D.......................Federal Furnace Co., S. Chicago, Ill.
Stauffer, Clinton R., *Geology*..............Adelbert College, Cleveland
Sterki, Victor, *Conchology, Botany*..................New Philadelphia
Stickney, M. E., *Botany*......................................Granville
Stockberger, W. W., *Botany*.......Dept. Agriculture, Washington, D. C.
Stover, W. Garfield, *Botany*..........................Stillwater, Okla.
Stout, W. E., *Chemistry, Geology*.........217 E. Mithoff Ave., Columbus
Surface, F. M., *Zoology, Botany*..........................Lexington, Ky.
Sweezey, Otto H......................Twelfth Ave., Honolulu, Hawaii
Todd, Joseph H., *Geology, Archaeology*........Christmas Knoll, Wooster
True, H. L...McConnelsville
Tyler, F. J., *Botany*.............................Perry, Lake County
Waite, F. C.....................Western Reserve University, Cleveland
Walton, L. B, *Biology*.......................................Gambier
Webb, R. J., *Botany*.....................................Garrettsville
Webster, F. M., *Entomology*.....U. S. Dept. Agricul., Washington, D. C.
Werthner, William B., *Botany*.............Steele High School, Dayton
Westgate, Lewis G., *Geology*..................................Delaware
Wieman, Harry L., *Biology*..............Univ. of Cincinnati, Cincinnati
Williams, Stephen R., *Biology*..............Miami University, Oxford
Williamson, E. B., *Ichthyology, Ornithology*..............Bluffton, Ind.
Wilson, Stella S., *Geography, Geology*........97 N. 20th St., Columbus
Wineland, L. A., *Chemistry*.................................Westerville
Wittenmyer, J. G., *Zoology*....................................Peebles

---

* Subject to ratification of the Society at the annual meeting, 1911.

WRIGHT, G. FREDERICK, *Geology*..................................Oberlin
YORK, HARLAN H., *Botany*........................Providence, R. I.
YOUNG, R. A., *Botany*..
...............Div. Seed and Plant Introduction, Washington, D. C.

Report of the Twentieth Annual Meeting

of the

Ohio State Academy of Science

ANNUAL MEETING

The twentieth annual meeting of the Academy was held at Buchtel College, Akron, Ohio, on November 24, 25 and 26, the President, Professor W. F. Mercer, presiding. On Thursday evening an informal reception was given to the members of the Academy by President and Mrs. A. B. Church. Acquaintances were renewed and a most enjoyable period spent by those fortunate enough to arrive Thursday evening.

The meeting was called to order on Friday morning at 9:00 in the Knight Chemical Laboratory after a preliminary session of various committees. President Church in behalf of the college extended a cordial greeting to all members of the Academy, and reviewed the scientific progress of which he had been observant in Ohio.

The regular business meeting followed, the president after a few brief remarks appointing a committee on membership and a committee on resolutions. The report of the Secretary was presented and accepted. This was followed by a report of the Treasurer, Prof. J. S. Hine, which after being referred to an auditing committee was accepted. The report of the Treasurer is as follows:

REPORT OF THE TREASURER FOR THE YEAR 1910.

For the year since our last annual meeting the receipts, including balance from last year, have amounted to $329.37, and the expenditures to $264.94, leaving a cash balance of $64.43.

RECEIPTS.

Balance from last year	$ 56 37	
Interest on endowment	2 00	
Membership dues	271 00	
Total		$329 37

DISBURSEMENTS.

190 subscriptions to The Ohio Naturalist	$142 50	
Printing annual report and price lists	66 25	
Miscellaneous expenses	56 19	
Balance due December 1, 1910	64 43	
Total		329 37

Respectfully submitted,

JAS. S. HINE, *Treasurer.*

The report of the Librarian, Prof. W. C. Mills, is as follows:

As Librarian of the Ohio State Academy of Science, I take pleasure in presenting my report upon the receipts from the sale of publications of the Academy and the expense of sending out the publications.

Cash on hand November 26, 1909	$ 1 42	
Sale of publications	26 88	
Total		$ 28 30

EXPENDITURES FROM NOVEMBER 26, 1909, TO NOVEMBER 25, 1910.

Letter postage	$ 1 42
Sending out Special Paper No. 16	6 00
Sending out Annual Report	6 00
Express	1 00
Stationery	1 25
Sending out publications during the year	1 66

	$ 17 33
Balance on hand	$ 10 97

Respectfully submitted,

Wm. C. Mills, *Librarian.*

Under the reports of Standing Committees, Prof. Lazenby, a trustee of the Emerson McMillin Research Fund, noted the continued interest of Mr. McMillin in the cause of science, through the gift of $250 toward the promotion of scientific investigation in Ohio. The detailed report follows:

FINANCIAL STATEMENT OF THE EMERSON McMILLIN RESEARCH FUND, OHIO ACADEMY OF SCIENCE, 1909-1910.

RECEIPTS.

Cash on hand November 1, 1909	$371 44	
Check, Emerson McMillin, November, 1909	250 00	
Total		$621 44

EXPENDITURES.

Dec. 13, 1909—G. E. Coghill, balance of grant of $50.00	$ 6 50	
Jan. 20, 1910—A. Dachnowski, expense in research	15 25	
Mar. 2, 1910—A. Dachnowski, expense in research	17 00	
Mar. 10, 1910—F. J. Heer, printing 500 copies Schaffner's fern list	47 50	
May 23, 1910—A. Dachnowski, expense in research	18 95	
June 20, 1910—Freda Detmers, expense in research	50 00	
Total		$155 20

Leaving balance in bank November 20, 1910, $466.24. Of this balance there has been appropriated but not yet expended $150.00, leaving an unappropriated balance of $316.24.

William R. Lazenby,
Edward L. Rice,
Frank Carney,
Board of Trustees.

The Publication Committee reported progress.

Under Special Committees, Professor Herbert Osborn, chairman of the Committee on the Natural History Survey, stated that conditions in the present legislature seemed adverse toward accomplishing the desired legislation. After some discussion the former committee was discharged, and a new committee consisting of Professors Carney, Osborn and Waite was appointed.

The report of the Committee on Conservation of the Natural Resources of Ohio was accepted and the committee discharged.

Under new business, Prof. Waite made the following motion, which was carried: "The Ohio Academy of Science extends to the American Association for the Advancement of Science and the affiliated societies, a cordial invitation to meet within the State of Ohio in the near future, and promises cooperation toward the success of such a meeting."

After the election of a Nominating Committee, consisting of Professors Carney, Osborn and Rice, the business meeting was adjourned until Friday at 4:30 p. m., while the Society proceeded with the reading of papers, adjourning at 12:00 m. for luncheon.

The afternoon session opened with the address of the President of the Academy, Prof. W. F. Mercer, a most interesting paper in which the Circulation of the Blood was considered in a historical way as well as the relation of the Circulation to Health and Disease. This was followed by the reading of the papers.

At 4:50 p. m. occurred the adjourned session of the Business Meeting. The report of the Nominating Committee was received and the following officers elected for the ensuing year:

OFFICERS OF THE OHIO ACADEMY OF SCIENCE FOR 1910-11.

President—Professor L. G. Westgate, Delaware, Ohio.
Vice-Presidents—Zoology: Professor Charles Brookover, Akron, Ohio.
Botany: Professor Malcolm E. Stickney, Granville, Ohio.
Geology: Professor George D. Hubbard, Oberlin, Ohio.
Secretary—Professor L. B. Walton, Gambier, Ohio.
Treasurer—Professor James S. Hine, Columbus, Ohio.
Librarian—Professor William C. Mills, Columbus, Ohio.
Trustee—Professor Frank Carney, Granville, Ohio (3 years).

Publication Committee—Professor E. L. Rice, Delaware, Ohio (3 years).
Executive Committee—Professor M. F. Guyer, Cincinnati, Ohio;
Professor E. L. Moseley, Sandusky, Ohio.

The following members were elected upon the recommendation of the Nominating Committee:

NEW MEMBERS ELECTED AT THE AKRON MEETING, 1910.

Fischer, Martin H., Experimental Medicine........................
....Univ. of Cincinnati, Cincinnati
Himebaugh, Oscar, Botany, Geology........................Akron, Ohio
Knower, H. M., Biology............Univ. of Cincinnati, Cincinnati, Ohio
Livingston, A. E., Zoology................................Athens, Ohio
Mark, (Miss) Clara Gould, Geology, Botany.......................
...............................Mt. Holyoke College, S. Hadley, Mass.
Rush, R. C., Conchology..................................Hudson, Ohio
Schilliday, C. L., Zoology................................Athens, Ohio
Snearline, A. L., Botany, Geology..........................Akron, Ohio

The names of members proposed by the Executive Committee and provisionally placed on the list of membership were also ratified.

The Committee on Resolutions presented the following:

The Ohio Academy of Science, desiring to express its sense of loss in the death of its late member, Professor W. G. Tight, has prepared the following brief memorial:

Professor Tight, although not a charter member, joined the Academy during the first year of its existence, and was elected its Secretary at the second annual meeting in 1892. In this position he faithfully served the Academy for two years, and was chosen and served as President for the year 1898.

Few members were more active or more enthusiastic in the work of the Academy during its early history than Professor Tight. From the first meeting in 1891 until he left the State ten years later he never failed to attend and always had something in the way of the results of research to present.

His energy and his unfailing devotion to science, together with a pleasing address and genial temperament, won the respect and esteem of his fellow members. His removal from the State to enter upon a larger field of labor was a decided loss to the Academy, and the news of his death brought a pang of regret to many of his old associates. Of him it may well be said his life was a record of useful service.

Be It Resolved, That we express our great appreciation of the continued interest of Mr. Emerson McMillin, whose substantial contributions have done and are doing so much to advance the scientific work of the Ohio State Academy of Science; and that we extend to him our sincere thanks.

Be It Further Resolved, That we extend our hearty thanks to the President, Trustees, and Faculty of Buchtel College, to Professor Brookover and the other members of the Local Committee, and to the Manufacturers of Akron, who have co-operated so happily in arranging for the entertainment of the visiting members and for the general success of the Twentieth Meeting of the Academy.

Edward L. Rice,
William R. Lazenby,
Francis L. Landacre,
Committee.

After the formal adjournment of the meeting at 5:45 p. m. a luncheon was served by the college in the Crouse Gymnasium, followed by a social gathering of the members and friends of the Academy.

At 8:00 p. m. Mr. F. A. Seiberling, President of the Goodyear Rubber Co., addressed the Society upon "The Rubber Industry," giving a most interesting account of his recent trip up the Amazon River, together with the description of the method of obtaining and preparing the crude rubber for the market.

On Saturday morning many of the members visited the factories of the rubber companies where the various mechanical methods involved in the preparation of rubber were exhibited. A few collecting trips were made and the members of the Academy departed from Akron with the remembrance of a most enjoyable session.

The complete program was as follows:

1 Anatomy and Physiology of the Unionidae. 10 min.
V. Sterki

2 The Olfactory Nerve of *Ameiurus* and *Lepidosteus.*

(Lantern slides.) 8 min. Charles Brookover

3 Further Notes on the Skull of *Eumyces.* (Lantern Slides.) 8 min. E. L. Rice

4 Diseases of Peat Soils. 10 min. Alfred Dachnowski

5 Notes on Ohio Trees. 3 min. W. R. Lazenby

6 Effect of Lack of Light on Amphibian larvæ. 7 min. A. M. Banta

7 Delaware Bird Records. 3 min. E. L. Rice

8 Catalogue of Ohio Vascular Plants. 3 min. J. H. Schaffner

9 Remarks on the Genus *Scaphoideus* with a Revised Key to the American Species. 7 min. Herbert Osborn

10 A Revision of the Genus *Symbiotes* with a Description of New Species. 5 min. L. B. Walton

11 A Revision of the Species of *Anasa* and *Cimolus* found in the U. S. 8 min. J. C. Hambleton

12 Preliminary Report on the *Agaricaceae* of Ohio. 12 min. W. G. Stover

13 The Occurrence of Apple Blotch in *Phyllosticta solitaria* E. and E. in Ohio. 6 min. W. O. Gloyer

14 The Known *Polyporaceae* of Ohio. 5 min. Lee Overholtz

15 Notes on Some Common Spiders found at Cedar Point. 8 min. W. M. Barrows

16 Producing Rubber from Milk Weed. 5 min. Chas. Fox

17 Notes on a Collection of *Boletaceae.* 5 min. Bruce Bink

18 Notes on Some Recent Collections of Hemiptera. 5 min. Herbert Osborn

19 Collecting Land and Fresh Water Mollusca. 7 min. V. Sterki

20 A Case of Bisymmetrical Cervical Fistulae in Man. 4 min. L. B. Walton

21 A Report on the Mammals of Ohio. 5 min. J. S. Hine

22 The Blister Rust of White Pine in Ohio. 3 min. A. D. Selby

23 On the Nature of the Reaction of Embryos of Amphibia to Hydrochloric Acid. 5 min. G. E. Coghill

24 The Development of Transportation in Ohio. 10 min. Frank Carney

25 The Mississippian Pennsylvanian Unconformity and the Sharon Conglomerate in Northern Ohio. 10 min. G. F. Lamb

26 Some Large Masses of Rock in the Drift. 7 min. G. D. Hubbard

27 The Olfactory Nerve in *Chrysemys marginata*. 5 min. Albert Meyers (Introduced by Charles Brookover)

28 The Placodal Ganglia of *Lepidosteus*. 7 min. F. L. Landacre

29 Leaf Markings of Certain Ohio Plants. 7 min. J. H. Schaffner

30 Descriptions of 11 New Fossil Fishes of the Corniferous Limestone. 10 min. Herman Hertzer

31 The Succession of Vegetation Groups of Ohio Lakes and Ponds. 5 min. Alfred Dachnowski

32 A Disease of *Pinus strobus* due to *Cenangium abietis*. 7 min. Bruce Fink

33 Keeping Quality of Apples. 7 min. W. R. Lazenby

34 New and Rare Ohio Plants Added to the State Herbarium in 1910. 5 min. J. H. Schaffner

35 Physical and Chemical Substratum Factors of Cranberry Island. 3 min. Alfred Dachnowski

36 Observations on *Protosiphon botryoides* (Kutz.) (Lantern slides.) 5 min. M. E. Stickney

37 The Classification of the Fresh Water *Oligochaeta* with Tables of Genera, Species, etc. 5 min. L. B. Walton

38 *Demonstration of Color Photography by the Lantern.* Paul Biefield

L. B. Walton, Secretary.

Gambier, Ohio, August 1, 1911.

PRESIDENT'S ADDRESS

By W. F. Mercer.

In presenting this paper I wish to deviate from the accepted form of papers and present the subject upon somewhat of a peculiar basis. In the first part of the paper I will trace the history of a great discovery, bringing out the methods of research necessary for such a discovery and in the second part of the paper I will try to show how a great fact in biological science may be made of practical benefit to humanity in the preservation of health and strength, that is, increasing our "health bank account" and to show how it would have been impossible to do this without the correct view brought out in the historical review. Many times too little attention is paid to the history in a science. The young mind takes the facts and knows nothing of the long struggle that was made to arrive at them. Many times the methods of research are brought out in the tracing of the history of a discovery better than in any other way. Beside that, the mind appreciates more the things that cost something in time and strength on the part of some one.

In studying the history of the discovery of the circulation of blood the mind is naturally turned to William Harvey but such a discovery can not be associated with the name of any one man. While the demonstration of the facts was left for Harvey in 1626, other men had been working on the question for more than 2000 years. The general structure of the heart; the working of the valves; the circulation of the blood through the lungs; the relation of the arteries and the veins to the heart; the valves in the veins; were all known before Harvey's time. One might ask what was left for him to discover? With-but doubt Harvey was the first to describe the circulation in its completeness. It will be noted later in this paper how much they knew of the structure of the organs of circulation and how little they understood their workings and what it all meant, but of course all of these discussions had their bearing and in the total makeup they must all have had their influence.

In the time of Homer the blood was known to circulate but the crudeness and the indefiniteness of the knowledge of the Greeks was very evident. To them the blood was contained in certain vessels and the body was permeated with another set of vessels which they called arteries because they carried air. They also knew that the heart was a hollow, muscular organ. The notion of the Greeks was not to be wondered at for their great respect for the dead rendered human dissection impossible. The little anatomical knowledge of the times had to be gained from the rapid observation of the parts of animals offered for sacrifice. Even Aristotle, whose anatomical knowledge was far in advance of the more ancient Greeks, made very little addition to the knowledge of the vascular system.

A great change was destined to be made soon, for Alexander was to conquer Egypt in the third century B. C., establish the Macedonian kings, and build the city of Alexandria with its great university, museums, and library. This was to be the center of learning of all kinds and especially the sciences, above all the study of medicine. Herophilus and Erasistratus were among the noted names from the medical school at Alexandria. In this school human dissection was common, so common that even the kings were known to attend the lectures and the demonstrations in the dissecting rooms. The foundation for the real knowledge of the circulation was laid here.

Herophilus demonstrated the relation of the beat of the heart to that of the arteries and that the beat of the heart was the cause of the beat of the arteries but he considered the arteries to carry only air. He compared the walls of the arteries with those of the veins and described the connection of the heart with the lungs calling the vessel leading from the right ventricle to the lungs the ARTERIAL VEIN and the one leading from the lungs to the left side of the heart the Venous Artery.

Science is indebted to Erasistratus for the discovery of the valves in the heart and their function in the circulation. It is also supposed that he saw the lacteals, which are a part of the lymphatic circulation. There is no doubt that the Greeks recognized two kinds of vessels but the fact that they considered the arteries to contain only air shows that they knew nothing of their true function. This can be accounted for from the fact that after death the arteries contain no blood as a usual thing, and from the supposition that these arteries had their origin in the trachea, hence the name "tracheal artery." Erasistratus traced the air from the trachea through the arteries to all parts of the body. During the next four hundred years human dissection, even in the Alexandrian school, gradually fell into disuse, but in the later part of this era there arose a man that was destined to become so world renowned that his word was not disputed in any particular for the next succeeding thirteen hundred years. Galen was born in 130 A. D., went to Alexandria at sixteen years of age and was practicing medicine at the age of twenty. He spent many years at different times in his life in Egypt studying anatomy. His dissections were limited to work upon the lower animals, but by ligating an artery in two places and opening it between the ligatures he showed that they contained blood, not air. This shows the great advantage of vivisection. The importance of this experiment can not be over-estimated for with the belief that the arteries carried air the true circulation could never have been discovered.

Galen did not believe with Erasistratus that the air entered the body but that it was rejected at once after it had served its function, which was to cool the body. He believed also that the right ventricle was in communication with the left by means of holes through the septum. Of course Galen never saw these holes, but his belief in the theory of the vital blood and the coarse blood was so strong, as it was for many years afterwards, that he had to see them in theory at least. The vital blood of the left ventricle had to be mixed with the coarser blood of the right ventricle, and the only way it could be done was for a part of the blood to pass through the septum and the remainder to pass to the lungs through the pulmonary artery. This is only an illustration of what happened many times in Galen's time and for many years afterwards and often happens even today, viz: that men have to account for certain things and to do this they must have a theory and they then have to see things to bear out the theory. But considering the fact that for sixteen centuries from the Alexanderian museum to the establishment of the school at Salermo in 1221 A. D., the human body had never been dissected, it is no wonder that we see evidences of the grossest ignorance of anatomy. The difficulties that stood in the way of dissection can be appreciated from the fact that Mundini, the professor of anatomy at Bolona during the latter part of the thirteenth century and the beginning of the fourteenth, dissected only three bodies in eleven years. The bettering of these conditions can be noticed from the work of DeCarpi, professor of anatomy in the same school a century later in that he dissected over a hundred bodies; and yet DeCarpi had such respect for Galen and his doctrines that he said there must be holes in the septum, but in discussing it he says they are seen with difficulty in man.

Michael Servetus, a Spaniard, published his Christianismi Restitutio in 1553 which was a short time after DeCarpi's works appeared. Servetus was a unique character in history. He studied for a priest at Saragossa; studied law at Toulouse; became secretary to Charles the Fifth at Bolona; soon gave up his diplomatic career for theology; studied medicine at

Paris; practiced medicine for some years, writing medical books meanwhile; returning to theology again he was burned at the stake in Geneva for heresy in the same year that he published his Restitutio. While this work is a theological treatise, it is of great interest to the physiologist for in treating of the vital spirit he describes the circulation of the blood. He disagrees with Galen from start to finish. According to Servetus the blood does not pass through the septum but passes from the right to the left ventricle by the way of the lungs, through the pulmonary artery to the lungs and the pulmonary vein from the lungs. Instead of the blood becoming vitalized in the left ventricle, as Galen held, it is done in the lungs. Servetus was the first to describe the pulmonary circulation and the first to discard the idea of there being holes in the septum for the blood to pass from one ventricle to the other. In fact he says there is no blood passing in this way. The idea of Servetus that the venous blood was changed to arterial blood in the lungs was not understood nor appreciated for more than a hundred years after his death. He also states that the left ventricle is not large enough for this mixture or elaboration to take place. This fact will be noted again farther on in the paper. I will quote the passage in the Restitutio that refers to the points in question.

"For which purpose the substantial generation of the vital spirit itself is first to be understood, which is composed of and nourished by the inspired air and most subtle blood. The vital spirit has its origin in the left ventricle of the heart, the lungs aiding, to the highest degree, in its generation. The spirit is subtle, elaborated by the force of heat, of a yellowish color, with the power of fire, to the end that it may be, as it were, a bright vapor from the pure blood, containing in itself the substance of water, air, and of fire. It is generated, in fact, in the lungs, with the mixture of inspired with the elaborated, subtle blood, which the right ventricle of the heart communicates to the left. Yet this communication is made, not by the middle wall of the heart, as is commonly believed, but the subtle blood is driven, by a great plan or device, from the right ventricle of the heart, by the long passage through the lungs; is prepared in the lungs; the yellow color is made, and it is poured out from the arterial vein (vena arteriosa or pulmonary artery) into the venous artery (arteria venosa or pulmonary vein); there it is mixed in the venous artery itself with the inspired air; is purged by expiration of its fuliginous matter; and so, at length, the whole mixture is attracted by the diastole from the left ventricle of the heart, a fit stuff out of which to make vital spirit." It will be noted that Servetus here considers the relaxation of the left ventricle to be the force that pulls the blood into it. Farther he says: "The various connection and communication of the arterial vein with the venous artery teaches that the communication and preparation is made by the lungs in this manner. The remarkable size of the pulmonary artery confirms this, which would be neither made in such a way nor so large, nor would there be emitted so great a mass of blood from the heart itself into the lungs, if for the nourishment of these alone, nor would the heart serve the lungs in this manner, since especially before, in embryo, the lungs themselves are accustomed to be nourished from elsewhere,. an account of these little membranes, or valves of the heart, not yet being open until the hour of birth, as Galen teaches. Therefore the blood is poured forth, and so copiously from the heart into the lungs at the hour of birth, for another use. The air also is sent from the lungs to the heart by the venous artery, not pure, but mixed with blood; therefore the mixture is made in the lungs. That yellow color is given to the blood by the lungs, not by the heart. The space in the left ventricle is not capable of holding so great and so capacious a mixture, nor is sufficient for that elaboration of color. Finally that middle wall, as it is wanting in vessels and power, is not fit for that communication and elaboration. even if some might sweat through. By the same plan by which the transfusion is made from the vena porta to the vena cava, with reference to the blood, so the transfusion from the arterial vein to the venous artery is made in the lungs, with reference to the spirit. If any one compares this with that which Galen writes, Lib. 6. et. 7. on the use of the parts, he easily perceives the truth, not observed by Galen himself. And so the vital spirit from the left ventricle of the heart is thus poured out into the arteries of the whole body."

Christianismi Restitutio is at present a very rare book. Of the 100 copies that were printed only three are known to exist at present. All of the rest are supposed to have been destroyed by fire with their author. There is some question as to the influence of this book upon the scientific world. It is strange that the great advance in the knowledge of the circulation of the blood should occur almost at the same time at Padua in the works of Vesalius and Columbus. Vesalius brought out his first work in 1543 in which he agrees with Galen that the blood passes through the septum but in the revised edition brought out in 1555 he doubts the proposition and almost states that it does not so pass. Servetus' work was in manuscript form in 1546 and it is known that several copies were sent to different parties and it would be prefectly natural that the great school of medicine at Padua would be the first to be influenced by this work although it was brought out especially as a theological work. There is nothing to be found in Servetus' work to indicate that he had the least idea of the systemic circulation and he evidently did not understand the passage of the blood through the tissue of the lungs for the capillaries were not discovered for more than a hundred years after. As has been stated above and in the quotation, it is evident that he knew that the blood passed through the lungs in passing from one side of the heart to the other but as to how it passed was entirely unknown to him.

In 1559 Matheus Realdus Columbus, six years after the death of Servetus, re-described the circulation and agrees in every respect with Servetus but says that it had never been described before, thereby claiming the discovery for himself. There can be no doubt but that Columbus had known of this new theory for Servetus is known to have sent a copy of his book to Padua where Columbus was professor of anatomy and had studied for some time with Vesalius. He may be excused for this claim under the circumstances for if he had referred to Servetus' work and agreed with him he would doubtless have suffered the same fate at the stake, for if he had recognized Servetus as a physiologist he would have been held as respecting him as a theologian. There may be, however, some question as to whether Columbus was familiar with the works of Servetus but there can be no doubt about his understanding the pulmonary circulation as well as could be understood without knowing of the capillaries.

Columbus says on the heart and arteries: "Cavities, that is, two ventricles, are present in the heart, not three as Aristotle thought. Of these one is on the right side, and the other on the left. The right is much larger than the left. The right contains the natural blood, but the left the vital blood. It is very interesting to observe that the substance of the heart surrounding the right ventricle is very thin but on the left side is very thick; and this is so arranged on the one hand to keep up the balance and on the other to prevent the vital blood which is exceedingly thin from transuding out of the heart. Between these ventricles is placed the septum through which almost all authors think there is a way open from the right to the left ventricle; and according to them the blood is in the transit rendered thin by the generation of the vital spirits in order that the passage may take place more easily. But these make a great mistake; for the blood is carried by the artery-like vein to the lungs and being there made thin is brought back thence together with air by the vein-like artery to the left ventricle of the heart. This fact no one has hitherto observed or recorded in writing; yet it may be most readily observed by anyone." He refers to the vein-like artery in the following terms: "Anatomists, not very wise, begging their pardon, in so doing, think that the use of this is to carry the changed air to the lungs which, like a fan, ventilates the heart, cooling this organ and not, as Aristotle thought, the brain. The same writers think that the lungs receive the, I know not what, smoky fumes (fumos capinosos) (for so in their ignorance of the tongues they call them) discharged from the left ventricle. About this, all one can say is that it pleases them, for they certainly seem to think that the same state of things exists in the heart as in a chimney, as if there were green logs in the heart which gave out smoke when burned, so far concerning the use of these parts according to the opinion of other anatomists. I for my part hold a quite different view, namely that this vein-like artery was made to carry blood mixed with air from the lungs to the left ventricle of the heart. And this is not only most probable, but is actually the case; for if you examine not only dead bodies but also living animals, you will find this artery in all instances filled with blood, which would by no manner of means be the case if it were constructed to carry air forsooth and vapours. Wherefore I cannot wonder enough at those anatomists who have not observed a matter so clear and of such importance, eminent though they wish to be considered by many of their fellows. But for these it is enough that Galen said so. What? To think that some folks in our time swear to the dogmas of Galen so that they dare to assert that Galen ought to be taken as gospel, and that there is nothing in his writings which is not true. It is wonderful how men are carried away by this doctrine; and the princes of anatomy offer it to the rabble. Yet no one sees how much this is to be blamed. Who indeed is there who never offends? But of this enough and more than enough." While Columbus cast away the theory of Galen that the blood passed through the septum yet he accepts the theory that the blood circulates in the veins only. "This is the use of the veins, to carry blood to all parts of the body in order to nourish them; for all the members of the body are nourished by the blood alone, therefore nature made the veins hollow for the sake of their function that like streams they might pervade the body." Although he makes great claims for his discovery he failed to appreciate the importance of it, as many did after his time.

Andreas Caesalpinus differed greatly from Columbus. Columbus lacked culture. His education was comparatively limited. Vesalius refers to him as the smatterer. The exact reverse of this was Caesalpinus. He was versed in all of the knowledge of his time. Born in 1519; we find him professor of medicine at Pisa from 1567 to 1592. He was an ardent follower of Aristotle's philosophy. He was a naturalist, for we find him teaching botany as well as medicine at Pisa. Being more of a philosopher than a naturalist he was inclined to dispute everything. He went so far as to not only dispute all that Galen said but to hold that all that Galen opposed was correct. He understood the working of the valves of the heart. "For the membranes are so placed at the orifices that they are opened when the heart is dilated and are closed when the heart is contracted." He still holds to the idea of the spirits and the two kinds of blood. He associated the pulse in the arteries with the beat of the heart and explained the working of the heart correctly in receiving and discharging the blood. He notices that the arteries expand when the heart contracts and that the valves are so placed that the blood can not get back from the arteries when the heart relaxes. "If therefore the arteries were dilated and constricted at the same time as the heart, it would follow that they would be dilated at the time when the material filling them from the heart was denied them, and constricted at a time when material was flowing into them from it. But it is manifest that this is impossible." He is the first to grasp the idea that the blood is discharged from the heart into the arteries and that the heart receives the blood from the veins, not only from the pulmonary vein but also from the venae cavae. He seems to get the idea of a connection of the arteries with the veins in some way. "The following matter seems worthy of consideration, the reason namely, why veins when ligatured swell on the far side and not on the near side of the ligature. But exactly the contrary ought to happen if the movement of the blood and the spirits took place in the direction from the viscera to all parts of the body. When a channel is interrupted, the flow beyond the interruption ceases; the swelling of the veins therefore ought to be on the near side of the ligature." The ebb and flow of the blood in the veins was a common belief by all until the time of Caesalpinus and there is no doubt that in setting forth his ideas he broke loose from the old Galenic beliefs, but knowing the temperament of the man and the spirit that prevails in all of his work, the question arises, how much of all this is due to his personal research or how much was the result of his spirit of controversy? In noting the little influence he and his ideas had on his contemporaries I am inclined to think that he knew very little about what he was writing from actual experience, but his ideas were the result of a very lucky hit in forming philosopical theories. Hieronymus Fabricius was the great contemporary of Caesalpinus and the one to add the next great step in the knowledge of the circulation of the blood.

Fabricius was born in Tuscany in 1537. During his early life he was hampered considerably by lack of means and opportunity, but we find him studying medicine at Padua under Fallopius, upon whose death he became the professor of anatomy in which capacity he remained for 40 years. He died at the age of 82 in the year 1619. He was well versed in all the knowledge of the biologic sciences of his time, writing many books on various subjects but the most important one of interest to this paper is the one on the valves of the veins, DeVenorum Osteolis "the little doors of the veins," which he published in 1574. These valves had been noticed some years before but he was the first on to carefully work them out. In his work he illustrated them with fairly good figures and gives the method of demonstrating them on the living specimen. He still held to the old theory of Galen, viz: that the blood flows out from the heart to the tissues in the veins and refers to the valves as a mere hindrance to the flow so it would not accumulate in the lower extremities to the detriment of the upper extremities. He says "little doors of the veins" is the name I give certain very thin membranes occurring in the inside of the vein and distributed at intervals over the limbs, placed sometimes one by itself, and sometimes two together. They have their mouths directed toward the roots of the veins (i. e. the heart) and in the other direction they are closed. Viewed from the outside they present an appearance not unlike the swellings which are seen in the branches and stem of a plant. In my opinion they are formed by nature in order that they may to a certain extent delay the blood and so prevent the whole of it flowing at once like a flood either to the feet, and to the hand or the fingers, and becoming collected there. For this would give rise to two evils; on the one hand the upper parts of the limbs would suffer from want of nourishment, and on the other hand the hands and the feet would be troubled with a continued swelling. In order therefore that the blood should be everywhere distributed in a certain just measure and admirable proportion for maintaining the nourishment of the several parts, these valves of the veins were formed." It will be seen that Fabricius did not grasp the true function of the valves at all. It was left for a pupil of his to clear up the points and demonstrate their use. He had many clear ideas of the process of respiration but we still hear him speak of the air reaching the heart through the vein-like artery and of the generation of the vital spirits. "If all this belongs to the innate heat of the heart which burns as with a flame, it must in any case be maintained that the whole business of maintaining and regulating that heat consists in the first place of providing material (for the flame), then for the ventilation, then of moderate refrigeration, and lastly of the discharge of the fumes; all these are supplied by respiration." It is with wonder that we sum up the works of

Fabricius for he must have known of the works of Servetus, of Caesalpinus, of Vesalius, and of Fallopius. He himself was a pupil of Fallopius who in turn was a pupil of Vesalius the greatest anatomist of his day, and if he had used his own knowledge of the valves in the veins rightly it would have overthrown the doctrine of Galen completely. He had such respect for old doctrines that his eyes were closed to "facts staring him in the face" and his ears were deaf "to voices crying out new views." "It was left for William Harvey, a pupil of his, to seize that which he had just failed to lay hold of, to weld together, as he was passing away, into one sustained and convincing argument, the several links which he and the rest had furnished, and nine years after his death to make known to the world that true view of the circulation which was the real beginning of modern physiology." (Foster.)

Harvey was born at Folkstone, England, in 1578. He was four years old when Fabricius published his work. Entering college at Cambridge in 1593, he took his arts degree in 1597 and left at once for Padua to study medicine in the greatest medical school of his day. He was made a doctor of medicine in 1602 after five years of hard work under the great master, Fabricius. We have already seen what the views of Fabricius were in regard to the circulation and respiration. Not being satisfied with the working of the old theories of Galen, Harvey at once, after returning to England, set to work to improve them. He developed his ideas in his lectures at the college of physicians in 1615. His book Exercitatio. however, did not appear until 1628. The method that prevails in all of Harvey's work is to advance from one thoroughly demonstrated point to another, not depending upon any one method of demonstration. He resorts to vivisection in many cases, not depending upon analogies or any course of reasoning to establish his points. His first work was to establish the movements of the heart itself. In doing this he found great difficulty in studying the live heart on account of its rapid movement, so much so that he nearly came to the conclusion that the heart was made for God himself to understand, not man. He used the lower forms in many cases for their hearts beat slower, and as a reward for diligent labor on many forms he discovered the true movements of the heart. He found that both ventricles beat at once and that the valves between the auricles and the ventricles were closed when the ventricles contract; that the valves at the opening of the arteries were pushed open at the same time and the blood forced into the arteries, not only the pulmonary artery but the aorta as well. It was the force of the contraction of the different parts of the heart that caused the movement of the heart, not the sucking of the blood from the relaxation of the heart as was believed by many up to his time; that the arteries swelled at one point or another on account of the pressure of the blood forced into them not that they might suck air into them. He saw how the auricles were a storehouse for the blood while the ventricles contracted; how they received the blood from the venae cavae on the one side and the pulmonary vein on the other. He had a complete understanding of the pulmonary circulation; how the pulmonary artery carried the blood to the lungs and the pulmonary vein brought the blood from the lungs to the left auricle. The old idea of Columbus and Servetus was that a part of the blood passed through the septum and the rest took the longer course through the lungs. If this was true for a part of the blood Harvey reasoned that it was true for all of it and he demonstrated it as a fact.

He speaks of this new view as one "to which some, moved either by the authority of Galen or Columbus or the reasoning of others, will not give their adhesion"; it led him to another conception which "was so new, was so novel and unheard of a character that in putting it forward he not only feared injury to himself from the envy of a few, but trembled lest he might have mankind at large for his enemies." This new view to which he refers is the application of the same principles to the greater circulation that he had already applied to the pulmonary circulation. He arrives at this conclusion from his estimate of the amount of blood in the body, and that arteries would become congested if there was no way for it to get out of the arteries; the body could not use up the blood as fast as it was made or absorbed from the viscera, therefore the blood must travel in a circle from the left side of the heart through the arteries of the tissues from the tissues to the veins through them to the right side of the heart, through the pulmonary artery to the lungs, through the pulmonary vein to the left side of the heart. In other words the blood must travel in a circle. He says: "I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be affected, and the like; and not finding it possible that this could be supplied by the juices of the ingested aliment without the veins on the one hand becoming drained, and the arteries on the other hand becoming ruptured through the excessive charge of blood, unless the blood should somehow find its way from the arteries into the veins, and so return to the right side of the heart; I began to think whether there might be a motion, as it were, in a circle. Now this I afterwards found to be true; and I finally saw that the blood, forced by the action of the left ventricle into the arteries, was distributed to the body at large, and its several parts, in the same manner as it is sent through the lungs, impelled by the right ventricle into the pulmonary artery and that it then passed through the veins and along the vena cava and so round to the left ventricle in the manner already indicated, which motion we may be allowed to call circular."

The heart is emptied when the vena cava is tied, the vena cava becomes distended when the aorta is tied, the limb becomes swollen when a tight ligature is supplied to shut off the veins, the same limb becomes pale when a tight ligature is applied to shut off the arteries, nearly all of the blood in the body can be drained away from a single opening in a vein. All of this can be easily understood in the light of

Harvey's discovery. "And now for the first time was clear the purpose of those valves in the veins, whose structure and position had been demonstrated to Harvey, by the very hands of their discoverer, his old master, Fabricius, who did not rightly understand their use, and concerning which succeeding anatomists have not added anything to our knowledge."

Harvey speaks of the spirits but casts it aside as not essential to his work. However, his discovery killed the idea of the natural spirits being carried by the veins and the vital spirits being carried by the arteries. He considers the blood the same blood all the time going in a circle meeting with change in the lungs and in the tissues of the body as it goes. His discovery leads easily to the understanding of the chemical phenomena going on in the body and the relation of the blood circulation to the nutrition in the body and the production of power for the body to carry on the processes necessary to its life. The fact that the food disappears from the alimentary canal and in some way becomes blood was known from the time men began to think of the activities in their own bodies, but how this was done was left to Harvey's time.

Gasper Aselli discovered the lacteals in 1622 in a way that some might think an accident. In working on the viscera of a dog he noticed some fine white cords in the mesentery taking them to be nerves at first, "but presently I saw that I was mistaken in this since I noticed that the nerves belonging to the intestine were distinct from these cords, and wholly unlike them. But presently recovering from his surprise he pricked one of the larger cords with a sharp scalpel and immediately a milky substance came forth. Afterwards he demonstrated this to many learned men and they were all "very much struck with the novelty of the thing." Aselli noticed valves in the lacteals and saw that they hindered the flow of the chyle, but doubtless influenced by the belief of the times that all of the food had to go to the liver for elaboration he supposed that these lacteals ended in the liver; in fact he said that he could trace them to the liver. It was left for Pecquet, a French physician, in 1651 to show that the lacteals ended in the thoracic duct which leads to the subclavian vein into which it pours its contents which has been partially absorbed from the intestine. The food thus received by the blood would at once proceed to the heart and from there be sent all over the body. If Pecquet had published his book thirty years before, his discovery would have been received as an impossibility. This simply shows what an influence the work of Harvey had upon the minds of men. Another argument was brought forward by Rudbeck in 1653 in publishing an account of another set of vessels that did not carry blood nor chyle but a clear watery fluid. These vessels are now called lymphatics. Rudbeck showed that these vessels carried their contents away from the tissues and toward the heart.

The importance of Harvey's work was not so much that the facts of the circulation of blood were made clear as it was the great field that it opened up for future discovery. The methods of experiment that Harvey used were a lesson for all future generations. After all of Harvey's study and description he never saw the connection of the arteries to the veins yet he said there must be a connection of some sort. This connection was the result of a course of reasoning with him, and it was left for Malpighi, after Harvey's death, to demonstrate the capillaries. Harvey had no microscope by which he could see them. He did all that was possible for him to do with the limited facilities at his disposal.

Many writers claim the honor for the discovery of the circulation of blood belongs to other men before his time, such as Servetus, Columbus, Caesalpinus and others. We have already discussed these men and their work and I think the place that they occupy in this history is clear. It was supposed that Sarpi made the discovery before Harvey and that Harvey copied his work, but it was found later that Sarpi had a chance to borrow a copy of Harvey's book and copied it largely for his own work. This manuscript was found after

Sarpi's death by his friends who claimed the discovery for him.

(Foster) "All such attempts to take away from Harvey what is his due are vain and useless efforts. The greatness of all great men is partly built on the worth of those who have gone before. In science no man's results are entirely his own, like other living things they come from something that lived before. Vesalius, Servetus, Fabricius, and the rest led up to Harvey; but they were not Harvey. He was himself, and his greatness is in no wise lessened by its having come through them."

In the second part of the paper I want to make Harvey's discovery apply to actual living mainly in the phase of muscular activity and show how the circulation of blood and the true notion of it, is important in every day life. To be sure men lived many years before they had the true notion of the circulation of the blood but I want to show that it is possible to live more and better by having the proper idea of the circulation of the blood.

The direct result of muscular activity, in a popular sense, is the strengthening of the muscles themselves. Many people overlook the indirect results and fail to see what bearing they have on the general health of the body; in their influence on the circulation of the blood and the lymph; the process of restion; the digestion of the food; in fact how the whole organism is tied up to these results. The popular notion is if we want strong muscles they must be exercised, if they are to be increased in size they must be exercised. This is very true but we will see later that this is a very small part as compared with the indirect results brought about by the grosser activities of the organism.

Every cell of the body must be fed. Every cell gets its food in just the same way as the amoeba, by absorption. To be sure the amoeba has the power of digestion to a limited degree because he is a generalized cell, but the bulk of his food, suspended in the water in which he lives, is absorbed into the cell substance directly. The body cells of the higher forms are specialized and cannot digest food for themselves. They are suspended in the body fluid, the lymph, in exactly the same sense as the amoeba, the difference being that these cells can not go after their food like the amoeba which may move about in the water from poorer to richer feeding grounds, but their food must be prepared and brought to them by the circulation of the fluid in which they are suspended. The blood circulates in a closed system of vessels and does not bathe the cells in general, but the lymph or body fluid has its origin mainly in the blood by dializing through the walls of the capillaries and bathes the cells of the body. The circulating media of the body carry on a double function. The distributing of the food has already been mentioned but the other side, the carrying the waste from the cells is as necessary to the life of the body as the food supply. Activity means waste in every place so every living organism is constantly producing matter that must be eliminated. The cells can not get away from it therefore it must be carried from the cells. If the cells can not get the food necessary and can not get rid of the waste matter, first they will starve and secondly they will be choked and death will be the result in either case. The body as a whole is alive or dead in proportion to the number of cells that are living or dead. The main point here is the absolute necessity for a circulatory medium and that this medium be kept in motion mainly on account of the specialized condition and the size of the human body. Small bodies like the amoeba can come in contact on all sides with the food, but with large bodies it is not so. To satisfy these conditions the blood must be put under pressure in the arteries. This pressure must be kept up and the arteries full of blood all the time. These conditions being mantained the blood will circulate to the points of least resistance. The resistance will depend upon the activity of the organ or organs in question. This will include muscular activity, glandular activity, etc. Any activity will force the blood out of an organ. In so doing the pressure is released in the organ and more blood comes to it on account of the elacticity of the arteries and the pressure in the general arterial system. Muscular activity is responsible for a large part of the reduction of pressure in the organs. The muscles of the arm for example upon contracting increase in diameter which causes pressure to be brought to bear upon the veins. There being valves in the smaller veins opening toward the heart the blood can go in but one direction, i. e.,, out of the organ toward the heart. A casual observation of the muscular activities of the body will show their importance and their general distribution. The digestive processes show it from beginning to end. The mastication of the food, the action of the stomach, and the action of the intestine in moving the food along, all are muscular action. The heart beat in pumping the blood into the aorta to keep up the pressure in the arterial system is muscular activity. The processes of respiration all depend upon muscular activity.

The rate of heart beat and the rate of respiration depends upon the general muscular activity, in that the greater the activity the greater the oxidation producing a greater amount of waste matter in the form of CO2. CO2 is the stimulant for the respiratory center which has control of the respiratory operations. Therefore the greater the muscular activity the greater the speed of the respiratory operation and the better the ventilation of the lungs. This means more air taken into the lungs, more oxygen absorbed into the blood, a greater amount of the life giving element with a subsequent better general health. Nature's method of bringing this about is shivering. If the temperature of the body becomes low for any cause the muscles are set into sudden contraction, which starts the circulation with the result as stated above. The heart beat depends upon the amount of heat in the blood and the lack of pressure in the aorta. Oxidation is producing heat while the CO2 is being made. The rate of heart beat is therefore increased in speed and the heart muscles themselves increased in strength to throw the blood into the aorta to keep up the pressure necessary for the distribution of the blood to the surface or to points of least resistance, which has a tendency to equalize the temperature by the loss of heat. The increased activity of the heart tends to increase the strength of the muscle fiber of the heart itself the same as the strength of any muscle is increased by exercise. Many failures of the heart to act in emergencies are accounted for from this lack of exercise. People of sedentary habits are more subject to weak hearts. A quick run for a train or any temporary sudden call for heart force is not responded to for the very reason that the heart has not been regularly exercised for strength to meet more than the regular calls of the organism. Result:—Sudden death; Cause:—heart failure. The arteries like the heart are called upon under like circumstances to stand a greater strain on account of the more forcible heart beat. They are made up of muscular tissue as well as elastic tissue. Unless they have been exercised properly they may give way or lose their elasticity from the great stretching on account of the weakness of the muscles.

Another element in the circulation of the blood and the body fluids in general is the suction force caused by the respiratory movements. These are all brought about by the activity of the muscles of the chest and the diaphragm. As the muscles contract, the chest cavity expands thereby reducing the pressure in the cavity. Since the blood is flowing toward the cavity in the veins, the lack of the pressure here will accelerate the blood in that direction. It will have a tendency also to pull the lymph in the same direction and to increase the flow of the lymph in the thoracic duct and the other lymphatic ducts that open into the veins which empty directly into the heart. The lymphatic vessels all have valves opening only toward the heart, so any movement of the lymph from any cause must be in that direction. We have already noticed that the lymph collects nearly all of the impurities and carries them to the veins near the heart. The increase in the percentage of the CO_2 in the blood stimulates the respiratory center in the medulla oblongata which will cause the muscle of the chest to act more rapidly thereby eliminating more CO_2 and gaining more oxygen. We have already noticed that the amount of blood going to an organ depends upon the pressure of blood in that organ. The pressure of blood in the organ depends largely upon the muscular activity in the organ or in the surrounding tissues. A sudden closing of the capillaries of the peripheral organs, which would never occur if the muscles were active, will naturally have a tendency to throw the blood to the internal organs causing a congestion. If there should be any weakness in any one of them that organ would suffer more than the others. Many chronic diseases are traced to this cause, for example, Bright's disease, diabetis, etc.

The reason for many of the common rules to govern exercise can be seen from the foregoing discussion, i. e. "We should not exercise vigorously on a full stomach." Exercise reduces the pressure in the peripheral organs which will naturally take the blood away from the internal organs where it is needed just at this time. Moderate exercise is not bad, for the digestive organs are stimulated by the presence of food which causes them to be active. The simple fact that they are active in movement or in the secretion of digestive fluids will cause less pressure in the organ and more blood will set in that direction in spite of a moderate call for blood in other directions. The whole thing is relative and if the balance is in favor of any organ that organ will get the blood necessary for it to do its work.

A muscle does not tire so much from the work that it does as from the impurities that it makes by its activity. In case that products of metabolism are made faster than they are carried off by the circulation the body becomes tired in proportion as the balance is in favor of the impurities. In the case of extreme exercise the muscle tissue is actually broken down faster than it can be built up, faster than food can be brought to it and the waste taken away. Extreme fatigue is the result. The system becomes clogged temporarily, which a period of rest will relieve by the blood having time to catch up in its work in carrying away waste and bringing food to the overworked parts. Here is the line between youth and old age. In youth exercise is spontaneous, but as people increase in age they must exert a will power to continue to exercise unless their occupation requires it. Unless they force themselves to it the heart and the arteries become weak and flabby from the lack of tone which is brought about by exercise and it soon becomes impossible to perform the feats of youth. In fact they lose all interest or desire to take part in any of the plays or spontaneous exercises of youth. Many a man has found that when he was called upon for a little more force than the ordinary, either through disease or in an emergency, he is found wanting and succumbs. It is well known that a man with a strong vigorous heart in pneumonia, other things being equal, will have the best chance for recovery. In fact the large percentage of deaths from pneumonia are from this very fact, heart failure, when if the patient had taken good regular exercise during health his heart would have been in shape to have brought him through. A man may become old while he is young in years. It all depends upon the circulation of the blood and the metabolism. That is upon which side is the balance. By tone as referred to above is meant the power to resist disease or to cope with an extra call if the time ever comes when the demand is made. The main business of life is to keep this tone as high and for as long a time as possible; i. e. to push our youth as far into life as possible. People as they advance in age resort to all means possible to avoid muscular activity and often deceive themselves in thinking that fresh air is a substitute for exercise. Often a horse and carriage with a hired driver is a great misfortune, for riding gives the minimum muscular activity. People whose occupation requires exercise indoors receive great benefit in out door air even if there is no great amount of activity at that time, but it is much better to get the exercise with the fresh air. It would be interesting and profitable to follow this discussion with familiar examples of abnormal development, diseased conditions both chronic and acute, caused by the lack of exercise which results in poor circulation of the blood and the body fluid, and how the increase of the circulation to a certain part, may remedy many unsightly forms, and diseased conditions of many organs, but the limits of this paper will not permit.

To keep well means to keep the circulation of the blood and the lymph up to the highest possible point and not overdo it. To get sick is to reduce the circulation below the upkeep point. To get well after disease does get a hold is to restore the circulation and bring it up and above the mere upkeep point. Dr. Knopf would express these conditions as the body being in physiological wealth or in physiological poverty.

From this paper it will be seen that I place great stress upon the circulation of the blood in physiology. Without a true knowledge of this system modern medicine would have been out of the question. The great feats of surgery which we witness today would have been unknown without Harvey's discovery. This is only one illustration of how any science is made up. One discovery after another makes it possible for the next. Without Harvey there could have been no Claude Bernard and others who have followed after to make the science of modern medicine and hygiene.